FRENCH REPUBLIC

# GRIGNON AGRICULTURAL

## EXPERIMENT STATION

(DEPARTMENT O EINE-ET-OISE)

DIRECTOR:

**M. P.-P. DEHÉRAIN**

Membre de l'Institut et de la Société nationale d'agriculture de France
Professeur au Muséum d'Histoire naturelle et à l'École d'Agriculture de Grignon.

TRANSLATED BY E. DEMOUSSY

Licencié ès sciences, at the Muséum d'Histoire naturelle.

ASSISTANT CHEMISTS OF THE STATION:

| | | | | | |
|---|---|---|---|---|---|
| MM. | Maquenne | 1875-1876 | MM. | Pol Marchal | 1881-1886 |
| | Nantier | 1876-1879 | | Paturel | 1886-1890 |
| | Meyer | 1879-1880 | | Hébert | 1890-1892 |
| | Kayser | 1880-1881 | | Dumont | 1893- . . . |

PARIS

IMPRIMERIE DE LA COUR D'APPEL

**L. MARETHEUX, Directeur**

SOCIÉTÉ ANONYME AU CAPITAL DE 135,000 FRANCS

1, RUE CASSETTE, 1

1893

FRENCH REPUBLIC

# GRIGNON AGRICULTURAL

## EXPERIMENT STATION

## (DEPARTMENT OF SEINE-ET-OISE)

DIRECTOR :

**M. P.-P. DEHÉRAIN**

Membre de l'Institut et de la Société nationale d'agriculture de France
Professeur au Muséum d'Histoire naturelle et à l'École d'Agriculture de Grignon.

TRANSLATED BY E. DEMOUSSY

Licencié ès sciences, at the Muséum d'Histoire naturelle.

ASSISTANT CHEMISTS OF THE STATION :

| | | | | | |
|---|---|---|---|---|---|
| MM. | Maquenne | 1875-1876 | MM. | Pol Marchal | 1881-1886 |
| | Nantier | 1876-1879 | | Paturel | 1886-1890 |
| | Meyer | 1879-1880 | | Hébert | 1890-1892 |
| | Kayser | 1880-1881 | | Dumont | 1893- ... |

PARIS

IMPRIMERIE DE LA COUR D'APPEL

**L. MARETHEUX, Directeur**

SOCIÉTÉ ANONYME AU CAPITAL DE 135,000 FRANCS

1, RUE CASSETTE, 1

1893

# GRIGNON AGRICULTURAL

## EXPERIMENT STATION

## (DEPARTMENT OF SEINE-ET-OISE)

---

### § 1er. — Description of the Station.

The experiment Station connected with the Agricultural School at Grignon was established in 1875.

The staff consists of a director who, being the professor of Chemistry at the School, has no additional salary as director, and an assistant chemist who receives 2,000 francs per year with board and lodging. The manual labour is done by a head-workman and a helper; when there is much to do supplementary workmen are employed; all these men are paid by the piece.

The government appropriation to the station is 5,500 francs per year, in which is included the salary of the chemist.

The experiment field, whose area is about one hectare, is divided in plots of one are, separated from one another by strips 50 centimetres wide. When the experiment field was first laid out, each of these plots received a special number which it has hept since; in each plot is a post supporting a small board on which are noted every year the nature of the crop and the manure applied.

A few years ago it was deemed necessary, for the investigation of drainage waters, to have a large number of glazed earthenware pots supported by iron tripods, and containing about 60 kilos of earth each, the portions in the different pots being taken from different soils. The rain water which percolates through the soil runs into glass jars, from which it is taken to be measured and analyzed. The pots are placed in a ditch, and sheltered from the sun's rays by an embankment on the south and by wooden boards on the east and west; they are also wrapped in straw.

This arrangement is very well adapted to the study of the drainage waters of soils bearing no crops, but is in general less suitable for experiments with culti-

vated soils. Although pots containing 60 kilos of earth may give good average yields of small plants such as rye-grass or clover, the larger plants, wheat, oats, beets, forage maize, do not thrive well in them. Accordingly for the study of drainage waters from cultivated soils, twenty vegetation boxes were made. Their capacity is 4 cubic metres, the surface being two metres square, and the depth one metre; the walls are made of an impervious cement in which is imbedded a wire netting to give it strength. The floor dips in the middle so as to form a gutter, and slopes towards the northern wall of the box. At the lower end of the gutter a leaden pipe is cemented, through which the water flows into large carboys; each of these latter is placed in a recess dug under the box. The boxes are sunk level with the surface of the field. In front is a ditch with a gentle slope; thus the carboys can easily be removed, the water measured, and samples taken for analysis.

On one side of the experiment field stands a small building with a weighing apparatus; here are kept the different samples of soils and seeds, and likewise the diagrams showing the crops obtained on the field.

At the same time that the Department of Agriculture decided to establish the Agricultural Experiment Station at Grignon, it intrusted Mr Dehérain with the publication of a special journal, the *Annales agronomiques*. This monthly Review is now in its eighteenth year; it not only gives an account of the lines of work pursued by the Grignon Station, but also publishes the researches of most of the French agriculturists. and gives abstracts of foreign papers. It thus makes known in France what is published in Germany, England, America, Italy, Russia, etc.

## SUMMARY OF THE LINES OF WORK PURSUED BY THE GRIGNON EXPERIMENT STATION SINCE ITS ESTABLISHMENT

### § II. — Exhaustion of arable land by continuous culture without manure.

When the experiment field was first designed, some plots were chosen for continuous culture without manure. In a few years some of them began to yield extremely small crops; thus in 1887 a plot, sown with sugar beets (Vilmorin's improved), yielded 10,100 kilos of roots per hectare, another 13,900 kilos (*See* below, Beet culture); in 1889, on a plot which had received no manure since 1875, the crop of scarlet clover, when freshly cut, weighed only 3,600 kilos, while the average crop on plots regularly manured was 15,000 kilos per hectare. In 1889, the yield of red clover on a plot regularly manured during the preceding years, was 8,800 kilos of hay; the constantly unmanured plots bore, one 3,200 kilos, another 2,600 kilos.

The soil that had received no manure since 1875 thus showed itself unable to

yield good crops of clover or beet in 1887; to what causes can we assign this fact? An explanation of this decrease in the fertility of the soil was to be sought for.

Analyses from time to time showed that the amount of nitrogen in the soil had constantly diminished for several years; but the decrease was less and less, and in 1888 it was found that the soil had regained a very small fraction of the nitrogen it had lost in the first years of the culture. (*See* diagram : *Losses and gains of nitrogen.*)

On the other hand, the percentage of organic *carbon* in the unmanured soil was considerably lower than at first; the organic matter had been gradually consumed, by slow combustion. Moreover its composition had materially changed, it had become much richer in nitrogen than the humic matter generally existing in the soil of Grignon. While the fraction $\frac{C}{N}$, *i. e.* the ratio of the carbon to the nitrogen, was represented by 8.4 or 8.5 for regularly manured plots, it barely reached 4.9 or 4.8 for the plots which had received no manure for several years[1].

From these numerical results we can at once conclude : that a rather light soil, like that of Grignon, ploughed every year and bearing crops, but receiving no manure, becomes considerably poorer in humic matter. Is this impoverishment the predominating cause of the observed sterility? Here, then, is the second question that had to be examined.

When we consider the enormous quantities of water absorbed and then evaporated by herbaceous plants, when we consider also that humic matter quite resembles a sponge, in easily retaining the water it receives, it is natural to assume that the loss of humic matter involves a drying up of the soil, thus diminishing the crops. But the determination of the percentages of water in the soils in the field, and a consideration of the quantities of drainage water from normal and from exhausted soils, showed that this hypothesis was untenable; for the numerical results evinced no difference as to their retentive power for water between the two kinds of earth.

Analysis of drainage water from the exhausted and the well manured soils showed that the nitrogeneous matter existing in the unmanured soil was easily converted into nitrates; accordingly, the sterility observed cannot be due to the disappearance of a nitrifiable nitrogeneous matter.

But if plants living in the exhausted soil can find the nitric nitrogen necessary for their growth, it may be that they have not sufficient mineral food. In 1880, before being exhausted, the unmanured soil contained from 1.3 to 1.7 gram of total phosphoric acid per kilo, and from 0.28 to 0.31 gram of phosphoric acid soluble in acetic acid; as the drainage waters contain but exceedingly small quantities of phosphoric acid, it was not supposed to have disappeared from the unmanured soil. Nevertheless a dressing of superphosphate was tried, and remarkable results were obtained.

While the soil without superphosphate yielded only 8 metric quintals (1 quintal = 100 kilos = 2,200 english pounds) of grain per hectare, the crop weighed 24 quintals on the soil that had received superphosphate, and 26 quintals when potassium chloride had been added to the superphosphate.

1. *Annales agronomiques*, vol. XV, p. 481.

Analysis showed that this soil, having received no superphosphate, still contained more than 1 gram of total phosphoric acid per kilo, but only a trace of phosphoric acid soluble in weak acids. Thus, when a soil, like that of Grignon, is left without manure, the phosphoric acid it contains becomes insoluble in weak acids and consequently unassimilable.

We must not fail to notice also that, if we can counterbalance the lack of farmyard manure by employing mineral manures in the case of wheat and probably of the other gramineæ, we cannot do the same for the leguminosæ; for, when dressings of superphosphate or of potassium chloride were applied on the constantly unmanured plots under clover, the crops were in nowise improved.

The writer was hence led to beleive that the sterility of soils unmanured for a long period, when bearing leguminous plants, was due to the particular mode of nourishment of the plants of this family which thrive only in soils containing assimilable humic matters. This is clearly shown in diagram n° 11, representing experiments on the evaporation by rye-grass and clover growing in soils with various manures.

The sterility following continuous culture without manure is thus due, partly to the transformation which the phosphoric acid undergoes in becoming insoluble and unassimilable, and partly to the disappearance of humic matter, the prefered food of the leguminosæ.

## § III. — Losses and gains of nitrogen by arable lands.

We have seen in the preceding chapter that, during the first years of the experimenting the arable soil of the experiment field had lost a rather large proportion of organic nitrogen; it now remains to state the importance of these losses and to seek their causes.

The results arrived at in this inquiry are recorded in the diagrams numbered I to 6.

# DIAGRAM N° 1.

## LOSSES AND GAINS OF NITROGEN IN THE SOILS OF THE EXPERIMENT FIELD OF GRIGNON UNDER DIFFERENT CROPS.

This chart shows the results of an extensive experiment, from 1875 to 1888. The object, as said above, was to see how a soil, receiving no nitrogeneous manure, becomes either poorer or richer in nitrogen according to the crops it bears.

The blue stripes, irregularly disposed on four of the lines of the drawing, represent the amount, in grams, of nitrogen in one kilo of earth at different dates, which are indicated by the figures at the bottom of the diagram.

Let us first consider plot *21*, represented in the left of the drawing, at the top. The first blue stripe on the left indicates an amount slightly exceeding 2 grams. That is to say, when the experiment field was first laid out in 1875 in a lucerne-field, the numerous analyses of a sample of earth, having the mean composition of the field, showed that one kilo of the soil contained 2.04 grams of nitrogen.

This plot *21* has been under potatoes, and has received no kind of manure since 1875.

In 1878 new samples of earth were taken in numerous parts of this plot, and the proportion of nitrogen was found to be much lower than in the beginning, 1.71 gram per kilo.

To determine whether this loss corresponded to the amount of nitrogen taken up by the four potato crops of 1875, 1876, 1877 and 1878, this quantity was calculated per hectare, and is represented on the diagram by the small green stripe on the second line; the nitrogen in the soil of one hectare in 1875, assuming that the weight of one hectare of soil to the depth of 35 centimetres is 3,850 tons (1 ton = 1,000 kilos = 2,200 english pounds), was calculated, also the nitrogen remaining in 1878; the difference between these two quantities was a number much larger than the one representing the amount of nitrogen removed by the crops. This difference, nitrogen lost, is figured by the black stripe corresponding to 1878.

In 1881 samples of earth were again taken from plot *21*, the amount of nitrogen was less than that in 1878, only 1.69 gram per kilo. Calculating this result to kilos per hectare, the loss, represented by the black stripe, is very small. It is even less than the weight of nitrogen taken up by the crops of potatoes in 1879, of wheat in 1880 and 1881, the green stripe being longer than the black one.

Since 1884 this plot has been under different crops, the yield naturally

decreasing every year. In 1888 we find only 1.5 gram of nitrogen per kilo of earth, the blue stripe corresponding to this year reaches in fact to 1.5. During this period, 1881 to 1888, the losses of nitrogen per hectare exceed the amount removed by the crops; so that the black stripe is longer than the green one. Samples were again examined in 1889, but as clover was sown in 1888, and followed by forage maize, the soil has become slightly richer. Accordingly we see on the second line a small red stripe showing the gain of nitrogen per hectare.

Looking at the blue stripes of plot *37* (third line, on the left), we see that, from 1875 to 1878 and to 1881, the soil has grown poorer in nitrogen; by comparing the black and green stripes, we find that this loss much exceeds what the crops have taken up. But in 1888 and 1889 the soil proved to be slightly richer; consequently on the last line of the diagram red stripes are drawn for these two years showing that the proportion of nitrogen is greater than in 1881, notwithstanding the fact that the crops removed the large amount of nitrogen represented by the green stripe of 1888.

On the right of the diagram we find the figures relating to plots *1* and *5*, which were under sugar beets in 1875, 76 and 77, and under forage maize in 1878. Although during this period plot *1* had received every year a dressing of 20,000 kilos of farmyard manure, yet the loss of nitrogen, as indicated by the analysis of 1879, is enormous; the blue stripe reaches only to 1.5 gram; the loss per hectare is represented below by a long black stripe, reaching much higher than the neighbouring green one, thus showing that the loss is not due to the removal by the crops.

The same changes in the proportion of nitrogen are noticeable on plot *5*, which was constantly unmanured; the blue stripe of 1879 is much shorter than that of 1875; on the other hand, the black stripe, indicating the loss, is rather long.

Since 1879 plots *1* and *5* have been sown with sainfoin, which has been cut every year; despite the large quantities of nitrogen thus removed each year, as shown by the green stripes of 1885 and 1887, the soil has become richer, not only while under leguminosæ from 1879 to 1884, but also while under gramineæ from 1888 to 1889 [1]. This gain is shown by the increasing lengths of the blue stripes, and by the lengths of the red stripes.

These numerous experiments show that a soil, originally under lucerne and rich in nitrogen, loses, during the first years of culture, an amount of nitrogen much surpassing that taken up by the crops; afterwards these losses alternate with, and are even followed by gains; these gains are small when the soil is ploughed every year, but become considerable if the land is laid down in pasture; thus from 1879 to 1889 the soil of plot *1* regained the nitrogen it had lost since 1875, when the experiments first began.

1. We cannot yet give a satisfactory explanation of the gains of nitrogen when the soil is under gramineæ.

## § 4. — Why arable land loses nitrogen.

Diagram n° 1 shows that the soil of the experiment field has lost considerable quantities of organic nitrogen during the first years of the experiments, and we have had to seek for an explanation of these losses.

We know that nitrates are not retained by the soil, and that any nitrogen that has been nitrified is either assimilated or lost.

Can nitrification be active enough in a soil to make it lose 1,000 or 2,000 kilos of organic nitrogen per hectare to the depth of 35 centimetres in four years; is it possible that, owing tho this nitrification, the drainage waters can carry away 250 or 500 kilos of nitric nitrogen every year?

In order to see with what activity nitrification goes on, experiments were instituted with results as figured in diagrams 2 and 3.

# DIAGRAM N° 2.

## RAIN-FALL AND DRAINAGE WATER
## BARE SOILS, MANURED OR UNMANURED

MARCH 1891 — MARCH 1892.

To estimate the losses undergone by soils of different characters, plentifully manured or totally unmanured, 66 large glazed earthernware pots are filled with soils from different localities. Each pot contains 60 kilos of earth, and its area is equal to $\frac{1}{60,000}$ of an hectare. The pots are in open air, the rain falls on the soil, and the percolating water is received in glass flasks below. The soils in one half of these pots are left unmanured, while each pot of the other half receives 1 kilo of good farmyard manure, a quantity corresponding to 60,000 kilos par hectare.

The soils differ widely in character. That of Grignon is silicious and clayey and very permeable. The soil from Wardrecques, department of Pas-de-Calais, is much heavier; well drained it yields splendid crops; the soils of Marmilhat and of Palbost come from the Limagne of Auvergne in the department of Puy-de-Dôme, they can yield average crops for a long while without receiving any manure.

The blue stripes on the left of the drawing represent the rain-fall (depth in millimetres) for each season of the year, and for the whole year; the rain-fall is slightly larger than the average observed in the country around Paris.

The red stripes show the quantities (depth in millimetres) of drainage water, for each season, from the manured soils; the green stripes in like manner show the quantities from the unmanured soils.

By comparing the lengths of the red and green stripes with those of the blue ones, we can see what relation exists between the rain-fall and the drainage water for each season of the year; dividing the rain-fall by the drainage water we obtain the following average figures for the soils without plants :

| | |
|---|---|
| Spring . . . . . . . . . | 2.5 |
| Summer . . . . . . . . | 3.1 |
| Autumn . . . . . . . . | 1.4 |
| Winter. . . . . . . . . | 1.1 |

In spring and especially in summer, the bare soils lose by evaporation much

of the water they receive, while in autumn a great part, and in winter nearly the whole, of the rain water flows through the soil and reaches the drains.

By comparing the red stripes with the green ones, we find that the farmyard manure has no influence upon the quantity of water that runs through the earth; the difference observed is sometimes in favour of the manured and sometimes in favour of the unmanured pots.

The stripes at the bottom of the chart show that water does not percolate through different soils with the same ease; more water flows through the two soils from Auvergne than through that from Grignon, and especially than through that of Wardrecques; and as the different soils require nearly the same amount of water to become saturated, we must assume that different soils evaporate different quantities of water.

## DIAGRAM N° 3.

### NITRIC NITROGEN (CALCULATED PER HECTARE) CONTAINED IN THE DRÂINAGE WATER OF BARE SOILS WITH OR WITHOUT MANURE

MARCH 1891 — MARCH 1892.

The red and green stripes show the amounts of nitric nitrogen contained in the drainage waters of the different soils, manured or unmanured, for each season of the year, from March 1891 to March 1892.

A glance at the green stripes, representing the amounts of nitric nitrogen washed out of the unmanured soils, shows that this quantity is entirely dependent on the nature of the soil. The Grignon soil, which is very permeable and not very rich in organic matter, nitrifies more easily than the Wardrecques soil, and much more so than the soils from the Limagne of Auvergne, which contain a large proportion of humic matter.

It is important to consider these differences; we can thus conceive that a soil nitrifying easily can bear large crops when it is in good condition, but that it more rapidly becomes exhausted than an another soil, where the nitrifying ferment does not thrive so well.

By comparing the red stripes between themselves, we find that all the soils do not nitrify the nitrogen of the farmyard manure with the same facility; for we can see, at the bottom of the chart, that the red stripes are not all of the same length.

We find also that it is in spring, that is to say, a short time after the manure has been worked into the soil, that the differences between the green and red stripes are the greatest; from this we infer that all the nitrogeneous compounds of the manure do not nitrify in the same manner, but that the ammonia salts are the first to be oxydized; the retardation of nitrification observed later on is due to the fact that the nitrogeneous organic matter is difficult to nitrify, it resists the action either of the ammoniacal ferments, or of the nitric organisms themselves.

Lastly, comparing the amounts of nitric nitrogen in the drainage water at different seasons, we find that manured soils lose the most in the spring, while with the unmanured soils the loss of nitric nitrogen is greatest in autumn.

These facts are very interesting because of their application to practical agriculture.

Let us suppose that a farmer wishes to manure his field so as to raise a good

crop of sugar beets, say, 50 tons per hectare. We know that a ton of beets requires 3 kilos of nitrogen, 1.5 for the leaves and 1.5 for the roots. So, during the period of active growth of the plant, the soil must yield 150 kilos of nitrogen; although we know that nitrogen is not solely absorbed as nitrates, but is also available as ammonia, yet we are sure that if the roots find sufficient nitric nitrogen, the plant will thrive well.

If the farmer does nothing but apply 60,000 kilos of farmyard manure, which is a very large quantity and often very expensive, his soil, if it resembles that of Grignon, will contain during the period of active growth about 177 kilos of nitric nitrogen, which is quite sufficient; but, for the three other soils the total nitric nitrogen we find in the drainage water in spring, summer and autumn, will not be sufficient, and nitrates should be added to give the plant the food it needs. The purchase of sodium nitrate, useless at Grignon in 1891, would have been necessary for the other soils.

If we assume that the soil of Grignon, when it was first ploughed to establish the experiment field, contained the same amount (perhaps even slightly more) of nitrogen as this same soil now, when it has just received 60 tons of farmyard manure, we can conceive how losses, similar to those of plots *21* and *37*, can be undergone; for we find that the bare soil of Grignon, manured, has lost 198 kilos of nitric nitrogen in a year, from March 1891 to March 1892. Multiplying this by 4, we find nearly 800 kilos for a period of four years, this figure is very near the one we have observed for the same plots from 1875 to 1878. On the other hand, the figures found for the nitric nitrogen in the conditions just named, do not explain the losses observed for plots *1* to *5*; and no facts can yet throw any light on what the other causes may be.

Before leaving this subject of drainage waters, it will be well to insist upon the losses caused by the washing out of nitrates and to show how they may be prevented.

## DIAGRAM N° 4.

### AUTUMN CATCH CROPS FOR RETAINING THE NITRATES GENERALLY WASHED OUT BY DRAINAGE WATERS

The results obtained with these catch crops are represented in diagram n° 4. On the left, the blue stripes indicate the loss of nitrogen, during the autumn of 1890, from bare soils where no catch crop had been sown. Similar soils were sown with mustard or rape just after harvest; the losses of nitric nitrogen in autumn 1890 are very small for these soils under the above named plants, and are represented by small green stripes on the right.

During the autumn of 1891 the losses are greater for bare soils than in the preceding year; we see in the diagram that the blue stripes are longer on the second line than on the first. Near these stripes is a blank space with only these words: « Vetch crop, no drainage water ». In fact the vetch crop was very luxuriant, and evaporated all the rain water it received, so that no water ran through the drains; consequently no losses occurred. When the crop consists of mustard or clover, a little water goes to the drains, but the losses are still prevented in a great measure [1].

At the end of autumn the catch crops were turned over and incorporated with the soil; but the soils, at that time, are not saturated with water as are bare soils, and the losses by drainage in winter are much less than those of bare soils.

These experiments thus show clearly that autumn catch crops prevent the loss of one of the most important agents of fertility. It is also very important to notice that the nitrogen, stored in the plants ploughed into the soil, reappears in spring, as nitrates, and so can immediately be assimilated by the plants which grow upon the soil at that time of the year.

The soils manured in this way by ploughing under, at the beginning or at the end of winter, the catch crops they had borne in 1891, were left bare in 1892, and the drainage water was collected. By comparing the red and green stripes, representing the nitrates washed out of the soils that have thus received green

1. In 1892 the same facts were observed for the soils in the vegetation boxes; with vetches the losses were very small but not entireky suppressed as in 1891. (*See*, diagram 5, boxes 7 and 8 compared with box 6.)

manures, with the blue stripes which refer to the unmanured soils, we can see how profitable this green manuring is. Instead of providing the crops of 1892 with 55 or 60 kilos of nitric nitrogen per hectare, as do the soils without green manures, those that have been under vetches can now supply 80 to 120 kilos of nitric nitrogen, and those under clover, 70 to 115 kilos. The differences are due to the initial richness of the soils that have received green manures.

Green manuring may be particularly recommended in countries where practical difficulties prevent the use of farmyard or commercial manures.

# DIAGRAM N° 5.

## DRAINAGE WATER FROM THE VEGETATION BOXES

PHOTOGRAPHS N°s 1, 2 AND 3.

The diagrams described in the preceding pages show the amount of water that percolates different soils, manured or not, but bearing no plants, also the amount of nitric nitrogen washed out by this water.

Diagrams 5 and 6 show the results obtained by the measuring and the analysis of the drainage water from soils under crops. The pots containing 60 kilos of earth, that we have adopted for the experiments on bare soils, are not suitable for these new investigations; large plants do not thrive well when their roots have only a small volume of earth in which to expand. After several years of fruitless trials, vegetation boxes were constructed in 1891, thanks to the liberality of the Department of Agriculture. These boxes are represented by photographs 1, 2 and 3.

They are in the form of a rectangular prism, two metres square and one metre deep, so that the volume is four cubic metres. They contain each about 5 tons of earth taken from the experiment field. As we have said, this soil is silicious, clayey, a little calcareous, and very permeable.

The sides are made of an impervious cement; the floor is covered with about two centimetres of gravel; carboys, that can be seen in photographs 1 and 2, receive the water that collects in the gutter and flows out through the leaden pipe. There are 20 of these boxes.

Four have borne no crops : n° *1* is without manure, n° *12* is a soil with 12 kilos of farmyard manure, n° *13* has received 12 kilos of farmyard manure and 100 grams of sodium nitrate, and n° *14* has been manured with 250 grams of sodium nitrate and 80 grams of superphosphate.

Box n° *2* has borne rye-grass, the principal graminea of grass lands (in France), n° *16* clover, n° *17* oats; no manure being applied. The drainage water of these can be compared with that from the bare soil of n° *1*.

Twelve kilos of farmyard manure have been applied in boxes : n° *3* bearing sugar beets, n° *8* bearing potatoes (Richter's Imperator), n° *15* sown with forage maize, and n° *18* bearing beets for seed. The drainage water from these boxes can thus be compared to that from n° *12*. N° *6* with wheat had 6 kilos of farmyard manure.

Twelve kilos of farmyard manure and 100 grams of sodium nitrate have been given to soils : n° *4* bearing sugar beets, n° *9* bearing potatoes, n° *19* bearing

beets for seed. The drainage water is to be compared with that from the bare soil n° *13*. N° *7* with wheat has only received 6 kilos of farmyard manure and 100 grams of sodium nitrate.

Lastly, mineral manures have been applied to : n° *5*, sugar beets, n° *9* potatoes, n° *20* beet for seed; the drainage water being compared to that from the bare soil n° *14*. Only 200 grams of sodium nitrate and 80 grams of superphosphate have been applied on the wheat of n° *8*.

In diagram n° *5*, the first line shows on the left the rain-fall during the period of active growth (March to November 1892). Although the crops, in the environs of Paris, suffered greatly from drought in spring and in the beginning of summer, numerous showers fell at the end of July and afterwards in October, and so furnished a good deal of water. Each box received 1,797 litres of rain water during the whole year. This amount corresponds to a height of 449 millimetres, which is much above the average; but this water has fallen too irregularly to be profitable.

The greater part of the water was evaporated, for the drains of the bare soils ran only twice in summer, on the 21st of July and on the 31st of August, and then continuously from the 11th of October to the 12th of November. 356 litres were collected from box n° *1*, bare and unmanured soil; about 400 litres flowed from each of the bare but diversely manured soils nos *12*, *13* and *14*.

The soils under crops gave much less water; those under sugar beets especially, which were very luxuriant (as can be seen on photograph n° 2, the leaves hang over the sides of the boxes pictured in the background), and moreover are dug very late. No water drained from the soils containing them until quite the end of autumn.

Box n° *6*, which bore wheat, and was without any crop in autumn, gave much more drainage water than nos *7* and *8*, which were sown to vetches immediately after harvest. Nos *18*, *19* and *20*, on which were beets for seed, furnished rather large quantities of water.

The soil of Grignon nitrifies very easily and rapidly; this year moreover nitrification was powerfully stimulated by the high temperature; the water from the bare unmanured soil contained a mean proportion of 150 grams of nitric nitrogen per cubic metre, about thrice the average observed at Rothamsted by Messrs. Lawes, Gilbert and Warington. The water from the bare but manured soils, was a little poorer in nitrogen. The results of these investigations on soils nos *11*, *12*, *13* and *14*, show what an amount of nitric nitrogen is washed out of a soil that has been enriched by previous manures.

Box n° *6*, which bore only a sickly crop of wheat and has had no catch crop, gave drainage water containing 140 grams per cubic metre. Where protective crops of vetches were grown, the water had much less nitrogen.

For n° *17*, oats and badly developped clover, the water contained also much nitric nitrogen.

The diversely coloured stripes on the last line of the chart, show the total amount of nitric nitrogen washed out of each soil. The figures, represented by these stripes, are obtained by multiplying the volume of water collected by the proportion of nitrogen it contained. We see that, while the loss for bare soils can exceed 150 kilos per hectare (n° *13*), it is very small when vegetation is luxuriant

and continues late in the year. The soils under beets have lost nearly nothing. The contrary has happened with n° *6*, where the loss, on account of there being no catch crop, corresponds to 50 kilos of nitric nitrogen per hectare. This is another example of the usefulness of these catch crops, which are really protection crops. We can see that the loss of nitric nitrogen is reduced to almost nothing for n$^{os}$ *7* and *8* which have borne luxuriant crops of vetches (photograph n° 3). Boxes n$^{os}$ *18*, *19* and *20*, where beets for seed were grown, lost rather large quantities of nitrogen, since this plant uses much less food in this period of its life than in the first year, when as sugar beet it is accumulating material from the soil.

---

## PHOTOGRAPH N° 1

*Vegetation Boxes of the Grignon Agricultural Station.* — General view.

## PHOTOGRAPH N° 2

*Vegetation Boxes of the Grignon Agricultural Station.* — Photograph showing how the drainage waters are collected.

## PHOTOGRAPH N° 3

*Vegetation Boxes of the Grignon Agricultural Station.* — Boxes *7* and *8* with the vetch crop in autumn 1892.

---

## DIAGRAM Nº 6.

### HOW THE NITROGEN OF THE MANURES IN DIVIDED BETWEEN THE CROP AND THE DRAINAGE WATER

The farmer is always greatly interested in knowing what fraction of the manure he has put upon his soil, remains there after the crop has been removed. Until a few years ago it was thought that this information could be obtained by calculating the difference between the nitrogen in the manure and the nitrogen in the crop. We know to-day that the problem is far from being so simple, and indeed cannot be answered with certainty. The soil itself furnishes food to the plant; but the quantity it furnishes is not measured exactly by determining the composition of drainage waters from bare soils. We know also that in some cases the soil can gain nitrogen from the atmosphere, that in other cases it can lose nitrogen, especially in nitrates washed out by drainage water. So, for the present, we must consider the problem as being far from being solved.

On the first line of diagram 6 we compare the nitric nitrogen washed out of a bare and unmanured soil, with the nitrogen of a crop grown without manure and with the nitric nitrogen contained in the drainage water from the same soil bearing the crop.

The violet stripe on the left of the first line shows that the bare soil has lost 56 grams of nitric nitrogen; calculated per hectare this loss amounts to 140 kilos.

Box nº *2* has been under rye-grass, which has been cut twice. The hay weighed 2.4 kilos, corresponding to 6,000 kilos per hectare. These 2.4 kilos contained 31.4 grams of nitrogen, which, added to 7.7 grams contained in the drainage water, give a total which is less than the amount of nitrogen lost by the bare soil. The quotient of the nitrogen of the crop divided by the nitrogen of the drainage water is $\frac{31.4}{7.7} = 4{,}0$.

The clover crop was rather small, it weighed only 1.1 kilo, corresponding to 2,750 kilos per hectare, and contained 22 grams of nitrogen, while 10.158 grams were found in the drainage water; the sum, as indicated by the two stripes, green and red, of nº *16*, is less than that of nº *1*; the quotient of the nitrogen of the crop divided by that of the drainage water is $\frac{22}{10}$ or 2.2

The oats on nº *17* were good; the yield was 1.1 kilo of straw, and 0.96 kilo of grain, corresponding to 2,750 kilos of straw and 2,400 kilos of grain par hectare. On account of the drought, the growth of the stems was slow, and the weight of the straw was small compared with that of the grain. The amount of nitrogen in the entire crop was 22 grams, or 55 kilos per hectare. The drainage

water washed out 12.4 grams. The quotient of the nitrogen of the crop divided by that of the drainage water is $\frac{22}{12} = 1.8$.

On the second line of the chart are represented the results obtained on soils which received farmyard manure only. The 60 grams of nitrogen, contained in the 12 kilos of farmyard manure, cannot be found in the drainage water from the bare soil, only 48.5 grams have been washed out. We must notice that the water from the bare and unmanured soil contained 56.3 grams, that is, more than the bare and manured soil; this fact is quite exceptional and did not obtain for the soils whose drainage waters are represented on diagrams 2 and 3. The soil of box n° *12* has thus become slightly richer.

N° *3* was under sugar beets. These were very luxuriant, the roots weighing 15.3 kilos, corresponding to 38,250 kilos per hectare, which is considered a good crop for sugar beets; the weight of the leaves was 7 kilos, about half that of the roots; the entire crop removed 48 grams of nitrogen. There was very little drainage water, and only 1.7 gram of nitric nitrogen were washed out of the soil. The quotient, as defined, above, is $\frac{48}{1.7} = 28.2$. By this we see that, when a crop is very luxuriant, like these beets, the loss of nitrogen by drainage becomes insignificant.

As we have said before, it is not solely to the exuberance of the vegetation that this result must be assigned, but also to the length of time the crop remains on the soil. Beets are dug very late and so evaporate large quantities of water until very late in the season. The case with potatoes is different; in box n° *10* the crop was very good : 15 kilos of tubers, or 37,500 kilos par hectare. These tubers, with their tops, contained 64 grams of nitrogen, the drainage water contained 7.28 grams, and the quotient of the nitrogen of the crop by that of the drainage water is $\frac{64.0}{7.3} = 8.7$, still rather a good figure, but considerably inferior to that obtained for the sugar beets.

The wheat of n° *6*, with a dressing of 6 kilos of farmyard manure, was bad. As nothing was sown after harvest, the drainage water washed out a large amount of nitrogen, and the quotient is $\frac{20.7}{21.8} = 0.9$. We find here, for the first time, more nitrogen in the drainage water than in the crop. This example illustrates once more the usefulness of autumn protection crops.

The 60 grams of nitrogen of the farmyard manure were not sufficient for the forage maize of box n° *15*, for the crop, when fresh, weighed 71 kilos and contained 76 grams of nitrogen, while only 5 grams were washed out of the soil; the crop contained consequently 15 times as much nitrogen as the drainage water.

On the third line are represented the results obtained when the dressing consisted of 12 kilos of farmyard manure and 100 grams of sodium nitrate, with 75 grams of nitrogen in the two manures. In no case do we find the nitrogen of the crop, plus that of the drainage water, equal to the nitrogen of the manure. A simple glance at the diagram shows that the only case in which sodium nitrate was notably efficient was with wheat; 22.2 grams of nitrogen were found in the crop, and, as vetches had been sown immediately after harvest, the loss by drainage was much lessened, so that the quotient of the nitrogen of the crop divided

by the nitrogen of the drainage water is $\frac{22.2}{6.8} = 3.2$, while for box nº *6*, this same quotient wass less than 1.

On the last line we find the representation of the results obtained on the soils manured with sodium nitrate only. In the first place it is a curious fact that, although 37.5 grams of nitrogen were given to the soil as sodium nitrate, box nº *14* lost by drainage but little more nitrogen than nº *1*. Since we cannot assume that the nitrate has not been washed out, we must conclude that the organic matter nitrified with particularly great rapidity in soil nº 1.

The manure was not sufficient for the beets of nº *5*, nor for the potatoes of nº *11*. The green and red stripes together are longer than the yellow ones. For the beets the ratio of the nitrogen of the crop to that of the drainage water is a little above 10; for the potatoes it is 8.8. The wheat, which had received a dressing of 200 grams of sodium nitrate with 30 grams of nitrogen, took up 23.6 grams of nitrogen; 7.1 grams were washed out, and the ratio is 3; this figure is rather large because vetches were sown in autumn.

In short, these two diagrams show that soils bearing crops lose but little nitrogen by drainage ; these losses are perhaps not sufficient to explain the decrease in the amount of nitrogen observed in the soil of the experiment field; since the year when the experiments began. But we must also bear in mind that well worked soils nitrify with exceeding rapidity.

However there may be other causes. Perhaps the soil contains microbes having the power of reducing nitrates even in presence of oxygen, as do some anaerobic ferments in a confined atmosphere. This fact has been observed by the writer and Mr. Maquenne, and by Gayon and Dupetit; it is also the conclusion of recent investigations of Mr. Bréal. But new experiments are necessary for explaining the causes of the decrease in the amount of nitrogen observed in the experiment field from 1875 to 1879.

## DIAGRAM N° 7.

### WHEAT CULTURE. — INFLUENCE OF THE VARIETY.

This chart represents : on the left, the yields per hectare of different varieties of wheat in 1885, 1886 and 1887 ; on the right, the financial results of this culture.

Above the line zero, carmine red stripes show the amounts of grain yielded per hectare by each variety for each year ; the yields of straw are figured by the blue stripes below the line zero. Thus we see that in 1885 the variety « Scotland Red », which is very similar to the « Golden Drop », gave 40 metric quintals (4,000 kilos) of grain and 76 metric quintals (7,600 kilos) of straw. In this year, 1885, the best crop was given by the « Sholley » (subvariety of the « Square Head »), and the smallest by the « Noah's Blue ».

In 1887 the two varieties, « Bordeaux » and « Noah », were left out, and the investigations were made with the « Scotland Red », « Browick » and two subvarieties of the « Square Head », the « Sholley » and the « Porion » ; this last proved to be the best. The crops however were not so good as in 1885. In 1888 the two « Square Head » varieties brought more than the « Bordeaux ». The average yield of the « Porion » Square Head is 3,500 kilos of grain, having a volume of 40 hectolitres (4,000 litres), which may be considered as a very good crop.

On the right of the diagram are figured the financial results; each of the stripes corresponds to the yield of grain and straw of the left half of the diagram; for instance, the first stripe refers to the « Scotland Red » in 1885, the second to the « Sholley » Square Head, and so on.

The profit obtained from a crop is the difference between the amount of money realized from the sale of this crop and the costs of raising; this profit is determined by the following simple équation :

$$P = R \times V - (E + L),$$

in which P represents the profit, R the weight of the crop, V the selling price, E the total cost of the manures, and L the rent, the cost of labor, etc. In the case of wheat the equation is not quite so simple, for to the term $R \times V$, weight of the grain multiplied by the selling price, must be added a similar term $R' \times V'$, weight of the straw multiplied also by the selling price. The sum $R \times V + R' \times V'$ is the gross receipts, and is represented by the sum of the orange red stripes and green, brown, etc., stripes on the right hand side of the drawing. Thus in 1885 the gross receipts yielded for the « Scotland Red » are 400 fr. + 725 fr. or 1,125 fr.

In order to leam the profit, we must substract from the preceding sum the regulare expenses : rent, taxes, costs of ploughing, sowing, reaping and thrashing. In the region near Paris all these amount to about 300 fr. per hectare. They are figured on the diagram by the green stripes under the line zero. To this expense we add all expended for manures. Of course, when farmyard manure is applied to a crop, we allow, by this mode of estimation, too large an expense for this particular crop; but it is so difficult to ascertain what fraction of the expense falls to each of the crops that are grown successively on the same soil, that we have preferred putting the total sum in account for the year in which it was expended.

This year, 1885, a very large quantity of farmyard manure, 35 tons per hectare, had been applied to the wheat, to see which varieties were the less liable to lodge; we reckon that a ton of manure costs 10 fr., which makes 350 fr. for 35 tons; if we add this to the 300 fr. of regular expenses we find 650 fr., at which height the brown stripe stops; but sodium nitrate, superphosphate of lime and potassium chloride have also been applied; the costs of these manures are represented respectively by the small blue, yellow and violet stripes.

All these expenses, amounting to 725 fr., substracted from the gross receipts 1,125 fr., leave the net profit 400 fr., represented by the orange red stripes above the line zero.

In this way we find that, if large quantities of manure are applied to a variety whose yield is small, like the « Noah's Blue », the profit is very low (fourth stripe of the right half of the chart). We see also how the profits increase when there is no expense for manure, allowing of course that the yield does not fall too low; this is what has happened in 1885 for the plots bearing « Bordeaux » wheat after clover.

In 1888 wheat brought a very high price, 26 fr. per 100 kilos and straw sold at 6 fr., so that, although the crops were generally inferior in weight to those of 1885, the profits were very large on account of the higher selling price and of the small expenditures for manures in that year.

The preceding experiments, which quite agree with those pursued in the Pas-de-Calais by late M. E. Porion and the writer of the present work, have much contributed to make known the advantages of the Square Head variety.

In 1886, M. Porion, with whom the writer has conducted field experiments on a large scale for four years, sold the greater part of his crop as wheat for seed; in 1887 and 1888 we sent lists of questions to the buyers, asking what results they had obtained with this new variety[1].

These results are resumed in the following table, which gives the average yield of grain in hectolitres (100 litres) per hectare, for 1887 and 1888, for the south, middle and north of France :

| | Hectolitres per hectare. | |
|---|---|---|
| | 1887 | 1888 |
| Southern France . . . . . . . . | 21.0 | 29.1 |
| Central France. . . . . . . . . | 33.5 | 36.2 |
| Northern France . . . . . . . . | 49.3 | 48.8 |

1. *Annales agronomiques*, vol. XIV and XV.

In 1888 some of the results observed in the north of France were remarkable. Five farmers reaped more than 50 hectolitres per hectare, one even 63. At Wardrecques, on M. Porion's estate, 50 hectolitres were frequently obtained with crops on a very large scale.

Since that time the numerous trials made by French farmers and agriculturists, have led them to adopt the « Square Head » variety, especially in the north; it is best known and is most successful in the departments of the Nord, the Pas-de-Calais, the Somme and the Aisne.

## DIAGRAM N° 8.

### WHEAT CROPS. — INFLUENCE OF MANURES

#### THE CROP OF 1887

As we have said, the « Square Head » variety does not easily lodge, so that large quantities of manure can be applied; the object of the investigations of 1887 was to find what quantities of farmyard and mineral manures it was best to apply.

The diagram shows the yields per hectare, the carmine red stripes above the line zero indicating the amount of grain in metric quintals (1 q. m. = 100 kilos), while the blue stripes beneath represent the weight of the straw.

The kind of manure applied is shown by the colour of the small squares beneath the blue stripes; the top line represents the manure applied to the crop in 1887, and the bottom line the manure applied in 1886.

Without manure in 1886 and 1887, the « Porion Square Head » (*1*) yielded 28.7 metric quintals, the « Sholley Square Head » 28.5 (*6*). When farmyard manure with sodium nitrate had been applied (*2* and *4*), the « Porion » yielded 34.5 and 35.7 metric quintals; the manure thus proved to be efficacious; the grain meighed 33.2 metric quintals when farmyard manure and sulphate of ammonia had been applied together (*5*), the yield being the same as when the manure consisted only of sodium nitrate (*3*).

The « Sholley Square Head » was sown after sugar beets, which had been grown in some cases with farmyard manure, in the others with no manure at all. An application of a little farmyard manure, 10,000 kilos, does not much increase the weight of the grain, but its effect is better felt on the straw (*7*). When 200 kilos of sodium nitrate are added to these 10,000 kilos of farmyard manure, the yield, grain and straw, is obviously much better; but if the amount of farmyard manure is increased, 20,000 kilos for (*9*), 30,000 kilos for (*10*), no improvement is seen.

As the season of 1887 was very hot and dry, the farmyard manure rotted badly, its ammonia was incompletely nitrified, the more so that more organic matter was present.

When the yield of a crop is not increased considerably by the use of manures, these become too costly; we can see this plainly on the right of the chart, where the financial results of 1887 are figured.

The estimations are made as above; the tolerable crop of *1* brought 480 fr.

net profit because nothing had been expended for manures. With *2*, *4* and *5* which receive large applications of farmyard manure, the profits decrease very rapidly, as can be seen in a glance at the orange red stripes corresponding to these various manures ; on the other hand sodium nitrate, applied alone, has given 550 fr. profit per hectare.

In this year 1887, as the farmyard manure did not increase the yield, we find, by comparing stripes 8, 9 and 10, that, as more and more was expended for manures, the profits became less and less.

The disadvantage of the use of farmyard manure in a soil nitrifying very easily like that of Grignon, is that, if spring is rainy, so much nitrate is formed at the expense of the mitrogeneous matter of the manure, that the crops are liable to lodge, as happened in 1889; but if the season is too dry, as in 1887, nitrification does not go on, the farmyard manure does not improve the crop, and the expense for its purchase considerably lessens the profit until the latter becomes insignificant.

## DIAGRAM N° 9.

### BEET CULTURE IN 1887

The investigations of 1887 were made in order to see how the value of a crop is influenced by the variety of the seed, and the kind and amount of manure applied.

The total length of the red and green stripes on the first line of the left part of the drawing represents the weight of roots per hectare. Plots *37* to *39* were sown with seed obtained at Grignon on seed beets issued from Vilmorin's improved. Plots *53* to *52* had been sown with seed coming directly from M. Vilmorin.

The colours of the small squares at the bottom of the chart point out the nature of the manure applied, as can readily be understood by a look at the legend on the right.

The beet requires much food. Where the soil has been impoverished by continuous cropping without manure (plots *37* and *53* have been unmanured since 1875), the yield of sugar beets is very small; it is about the same when soluble nitrogeneous manures are applied, sodium nitrate on *39*, sulphate of ammonia on *38*; the crop becomes very good when farmyard manure si applied. alone (*35.36*) or with saline manures (*33* and *34*).

In France the sugar manufacturers pay for the beets according to the sugar content, the percentage being generally estimated by the specific weight of the juice. This determination was made in the roots of the various plots. The percentages of sugar (grams in 100 cubic centimetres, or 1 decilitre, of juice) are represented by light red stripes on the second line. The lengths are not at all the same for the different plots. When the plant found but little food, *i. e.* had received little or no manure, the percentage of sugar was very low. The roots of plots *49*, *50-56*, *51*. *52* and especially *33*, *35-36*, and *34* are very rich, the proportion of sugar in the juice of the beets grown on plot *34* even exceeded 19 per cent.

Knowing the percentage of sugar in the juice, we can calculate the percentage in the beet itself, and, by multiplying this last figure by the weight of the crop, the total amount of sugar for one hectare, represented by the green stripes on the first line. This quantity, small for plots *37*, *38*, *39* and *53*, varies between 5 and 10 tons per hectare for the other plots.

The price of a ton of sugar beets depends ou the percentage of sugar. This price is represented by the length of the yellow stripes on the last line on the left of the diagram. It varies from 24 fr. 40 for plot *37*, to 32 fr. 80 for *33*, *34*,

*35*, *36*. It corresponds to a specific gravity of 8° 3. The price of the Vilmorin is a little lower, 32 fr. 20 for *50*, 31 fr. 60 for *51*, and between 26 fr. 20 and 29 fr. 80 for the other plots.

On the right of the chart we find the financial results. The gross receipts are obtained by multiplying the price of the ton of beets by the number of tons representing the crop on one hectare. For instance, for plot *37*, multiplying 13.9 tons by 24 fr. 20 we find only 336 francs, while the crop of *33* could be sold for 1,098 fr.

To have the net profit, from the gross receipt we substract all that has been expended for the raising of the crop ; the regular expenses for the beet culture, about 160 fr., are rather higher than for wheat, because the different operations, hoeing, digging and carting are more expensive than the reaping and thrashing of the wheat. The regular expenses are represented by the green stripes below the line zero ; to these we add the expense for manure, as was done above for wheat. The expense of manure is charged to the crop on which it was applied.

In four cases the expenses exceeded the gross receipt, and consequently instead of a profit we find a loss, represented by a black stripe above the line zero. This is what the farmer would have been obliged to supply in order to balance his expenses.

We can easily see that when sugar beets are grown on a soil exhausted by constant cropping without manure, instead of a profit there is a loss, which exceeds 100 fr. for *37*, and 200 fr. for *53*. We find also a loss, but very slight, when sulphate of ammonia alone is applied.

If too much is expended for farmyard manure, as on plot *49* which has received 60,000 kilos, the loss is still considerable ; on the contrary, if moderate quantities of farmyard manure are applied the profit exceeds 300 fr., especially if sodium nitrate is added as for *34*.

# DIAGRAM N° 10.

## OAT CULTURE. — INFLUENCE OF THE VARIETY

In 1886, 87 and 88, experiments were instituted at Grignon in order to acquire information regarding the values of different varieties of oats.

The results are figured in the left half of the diagram; the name of each variety is written under each stripe, at the bottom of the chart.

The carmine red stripes above the line zero represent the weights of grain from one hectare; the weights of straw per hectare are represented by the blue stripes below the line zero. These data are shown for the different varieties and for the three years 1886, 87 and 88. In 1886 the variety « Géante à grappes » yielded 40 metric quintals of grain, and 75 metric quintals of straw. This variety is unilateral, its colour yellow; the originator is M. H. de Vilmorin. This year it well earned its name of « Giant » oats, for the straw was very long; but it shortened in the ensuing years and the yields were never as good as in 1886.

The « Salines » is also yellow, and is grown in the north of France especially. It thrives exceedingly well in temperate climates, but cannot withstand a hot summer. In 1892, in Central France, quite inferior crops were raised.

The « Coulommiers » variety is best known around Paris; in 1886 it yielded as much straw as the « Giant », but less grain.

The two varieties « Poland » and « California » proved to be inferior to the preceding, although they were manured in the same way.

In 1887 three varieties were experimented with, the «Giant», the « Salines», and an English one, bearing the rather queer name of « Potatoes ». The yield of straw was about the same for all the varieties, but the « Giant » yielded more grain than the other two. In 1888 the « Salines » was decidedly the best as can be seen in the chart.

On the right of diagram n° 10 we find the financial results corresponding to these yields. The gross receipt is the sum of the values of the grain (weight of grain multiplied by the selling price), and the straw (weight of straw multiplied by the selling price). It is represented in each case by the total length of each stripe on the right half of the diagram. From this sum we substract the regular expenses, rent, taxes, labor, etc., amounting to 300 fr.; these expenses, which are the same for all the crops, are represented by the green stripes below the line zero. To them we must also add what has been expended for manures.

In 1886 the variety of oats « Géante à grappes » only received 200 kilos of sodium nitrate, costing 55 fr. Substracting the total expense 355 fr. from the

sum for which grain and straw have been sold, we have the profit, about 620 fr., represented by an orange red stripe above the line zero.

The other varieties, « Salines, Poland, California, Coulommiers », all received the same manure : 10,000 kilos of farmyard manure, valued at 10 fr. per 1,000 kilos all laid, 40 fr. of sodium nitrate (150 kilos); in all 140 fr. worth of manure, which, with the 300 fr. regular expenses, amount to 450 fr. to be substracted from the gross receipt. The profit is greater for the « Salines » oats than for the three others, but still a little less than for the « Giant », which grew on a plot strongly manured in 1885, but without farmyard manure in 1886.

The « Giant » is again the best in 1887 ; in 1888 the two varieties yield very good profits, as straw sold very high that year.

In a climate like that of Grignon the variety of « Salines » is certainly the most profitable.

# DIAGRAM N° 11.

Herbaceous plants evaporate exceedingly large quantities of water. From the researches of Lawes and Gilbert, Haberlandt and Hellriegel, it follows that, for one part of dry matter elaborated, from 250 to 300 parts of water are evaporated by the plant. Lawes and Gilbert and Hellriegel have also shown that the proportion of water evaporated increases very rapidly if the plant is growing in a medium poor in plant food.

In this way, knowing the amount of water evaporated by a plant, we can tell whether the manures applied accord with the nature of the plant; and the writer has employed this mode of investigation to demonstrate that the gramineæ of grass land, like rye-grass, do not feed in the same way as the leguminosæ, like clover.

In 1891 two series of experiments were instituted on rye-grass and on clover; each comprised :

1° A soil which had been unmanured since 1889, but had previously received plentiful dressings of farmyard manure;

2° A soil unmanured since 1875, and having therefore lost a considerable quantity of humus; this soil receives no manure;

3° The same exhausted soil, but with chemical manures, sodium nitrate, ammonium sulphate, superphosphate of lime and potassium chloride, enough for a good crop;

4° and 5°. This same exhausted soil, to which was added some of the dark brown liquid which drains from manure heaps. The composition of the latter, including the percentages of nitrogen, phosphoric acid and potash was known. In order that 4 and 5 might have the same amount of these substances as 3, chemical manures were also added to supply the deficiencies. In short, 3, 4 and 5 of each series received the same amount of plant food, nitrogen, phosphoric acid and potash, but 4 and 5 had also humic matter which 3 had not.

These soils were in large pots similar to those previously described.

The weights of the crops of rye-grass and of clover are represented by the stripes on the top line of the diagram, the rye-grass on the left, the clover on the right. The stripes are colored : blue for the crops without manure; red, for the crops with chemical manures; brown for the crops with humic matter.

The rye-grass crop is best where chemical manures have been applied, rather low when humic manure has been added, and bad when no manure at all is present.

Quite different results have been obtained with clover, as can be seen on the right of the drawing. While the soils with humic matter bear the best plants by far, the crops with chemical manures are not much better than those on the soil

unmanured since 1875, and are a little inferior to those grown on the soil unmanured since 1889 and containing more humus than the preceding one.

On the second line we find the amount of water evaporated by each crop. We assume that it is represented by the difference between the rain-fall and the drainage water; this is a sufficiently close approximation, for, as the surface of the pot is completely sheltered by the crop, the soil loses by evaporation so little water that it can be neglected.

We must notice that all the pots have evaporated about the same amount of water; this is very singular, for great differences were found between the weights of the different crops.

Finally, the stripes on the last line represent the weight of water evaporated by each crop for 1 gram of dry matter (ratio of the total amount of water evaporated to the weight of the dried crop). Without manure the gramineæ waste very much water, from 620 to 675 c. c. for 1 gram of dry matter elaborated; but if they find plenty of food, the evaporation falls to 220 c. c. per gram of dry matter elaborated.

The results are not the same for the clover; but little water is evaporated when the manure contains humic matter; with chemical manures, which are not very favourable for the growth of the leguminosæ, the rate of evaporation is 400 c. c. per gram of dry matter; it is 450 c. c. for the crop on the exhausted soil, and only a little more than 300 c. c. for the crop growing on the soil manured in 1888 and still containing some humus.

From these experiments we conclude that in dry climates, where the success of a crop depends almost exclusively on the amount of water the plants find in the soil, it is of the greatest importance to give to the plants manures fitted to their wants, so that the least amount possible of water may be evaporated in order to elaborate the dry matter of the crop.

(See : *Ann. agron.*, vol. XVIII, p. 465.)

# DIAGRAM N° 12.

## CROPS RAISED ON NEWLY BROKEN UP GRASS LANDS

by M. Paturel,

Assistant Lecturer in Chemistry at the Agricultural School of Grignon.

These experiments, the results of which are represented in diagram n° 12, were instituted at the Agricultural Station in 1890 in order to obtain light upon two different subjects : 1° to find which of the usually cultivated varieties of potatoes yields the largest crop, and also which contains the greatest proportion of starch; 2° to compare the relative fertility of two series of soils, the first being newly broken up grass land, which had accumulated a large amount of nitrogen, while the second had been enriched by previous applications of farmyard manure. We shall treat successively of these two subjects.

The varieties experimented with were the « Van der Veer » and the « Chardon » (Thistle), which are still the best known in this part of France, and the « Richter's Imperator », advocated in the last few years by M. Aimé Girard, professor at the Conservatoire des Arts et Métiers in Paris.

On the first line of the drawing we find the yield per hectare for each variety and for each soil; on the middle line, beneath the yield, is represented the amount of starch per hectare for each experiment. These latter figures are the results of analyses in the laboratory. Lastly the financial results are represented on the third line. The regular expenses for ploughing, tillage, etc., were estimated at 300 francs per hectare; nothing was expended in manures, as none was applied, farmyard or chemical. The net profit per hectare is represented by the red stripes above the line zero. We assume that the price of potatoes is 4 francs per 100 kilos, which is the usual selling price inFrance.

The first three stripes on the left of the drawing show that plots 2, 3 and 4 have yielded nearly the same weights of tubers, between 20,000 and 22,000 kilos per hectare. This is also the case for the three following experiments in which the yield is between 16,000 and 18,000 kilos. None of these three varieties proves to be superior to the others when they are grown on soils that have long been under grass.

The yield of starch is also nearly the same for each variety; still in each case the « Richter's Imperator » yields a little more than the two other varieties. But in the third series of experiments the « Richter's » proves to be superior to the others by far, for the total weight of tubers and for the amount of starch; the crop weighs nearly 40,000 kilos, corresponding to 8,400 kilos of starch, while the two other varieties yield only 4,500 kilos.

It is most important to consider the great differences between the yields in the third series of experiments and those in first two series. The yields represented by the six stripes on the left of the diagram pertain to soils which, having borne various crops from 1875 to 1879, have therefore lost much organic nitrogen, about a fourth of the total amount (see: diagram nº 1). These losses are due, as we know, to a removal of nitrogen by the crops, and to a washing out of nitrates by drainage water, especially in autumn; a considerable quantity of nitrogen is lost every year in this way. The soils thus impoverished were put under grass in order to regain the original proportion of nitrogen. Ten years were necessary for this; in 1889 the percentage of organic nitrogen was the same as it was at first in 1875. These grass lands were then broken up and cultivated in the usual way [1].

On the contrary the soils, to which the last three results on the right of the drawing belong, have, from 1875, been cultivated on the usual rotation plan and regularly manured. In the preceding year, 1888, the crop was sugar beets, and 30,000 kilos of farmyard manure had been applied.

Here the « Richter's Imperator » finds all the conditions for its full development, and so has yielded about twice as much tubers, and thrice as much starch as it did on the broken up grass lands.

It is also interesting to remark that there is a difference between the results of the two series of experiments on the plots from grass lands. The results, represented by the first three stripes on the left, are decidedly better than those of the second series. This must be assigned to the large amounts of farmyard manure which have been applied from 1875 to 1879; and it is a curious fact that, after more than ten years, this manure has left in the soil substances which can still slightly stimulate growth. As M. Dehérain has often shown, and as we see here, farmyard manure is, for the light soil of the experiment field, certainly the best kind of manure to be applied; its effects are extremely beneficial and persist for a long while.

The financial results, on the last line of the diagram, show the inferiority of the plots from the broken up grass lands, when compared with the soil which has been regularly manured and under the ordinary rotation system. In the first case the « Richter's Imperator » gives but small profits; the « Van der Veer » is first with 600 fr. net profit per hectare. In the last series of experiments the results are really splendid, 1,260 fr. net profit are obtained with the « Richter's » four times as much as on the poorer soils from grass lands [2].

1. See *Annales agronomiques*, t. XVII, p. 337. *Enhausture of arable land by continuous culture withont manure*, by Mr. P.-P. Dehérain.

2. M. Aimé Girard has published a paper on *The potato culture* (Gauthier-Villars). — The results obtained urth the Richter's Imperator are recorded, in the *Annales agronomiques*, vol. XVII, p. 136.

From these experiments we may conclude that if a soil under grass becomes richer in nitrogen, its fertility is not increased in the same proportion. The organic matter, that has been accumulating in this soil during these ten years, is probably in a stage of decomposition not so advanced as is the farmyard manure; these reserve substances will be but slowly taken up by the crops, by degrees as nitrification goes on, and as the nitrogeneous matter is changed into nitrates, under which form nitrogen is so easily assimilated by plants.

Paris. — Imprimerie de la Cour d'appel, L. Maretheux, directeur, 1, rue Cassette.

# NOTICE

## CONCERNING THE FOUR DIAGRAMS

EXHIBITED BY


## M. D. ZOLLA

**Professor of Rural Economy at the Grignon National School of Agriculture**


### DIAGRAM No. I

A few years ago the Academy of Moral and Political Sciences proposed, as a subject for competition, the following question :

" History, from an economist point of view, of the value of land, and the revenues derived from it, in the 17th and 18th centuries in France. "

It was necessary to make researches on the value and returns of the rural domains in various regions in France during that length of time.

Mr Zolla, whose Memoir was crowned by the Academy, exposes the results of his researches in Languedoc, Maine, Anjou, Normandy, and Burgundy.

The curved lines on the figures show the variations in farm rents on several hundreds of rural domains belonging to Hospitals or Religious Establishments, which possessed large estates in France before 1789. It will be observed that, during the prosperous reign of Henry the Fourth, from 1600 to 1610, the revenues derived from the land increased. It was the same, during the first years of the reign of Louis the Fourteenth, and during those which preceded the Revolution of 1789. On the contrary, during the long wars of Louis the Thirteenth, and of Louis the Fifteenth, the land diminished in money-value.

Mr Zolla thinks that the price of agricultural produce has a very great and decisive influence on the value of the soil. The second figure thus explains the first.

### DIAGRAM No. II

The curved lines show :

First : the prices of meat.

Secondly : the prices of milk and butter.

Thirdly : the prices of corn.

It will be observed, that the prices of these articles of food increase or diminish at the same time as the revenues derived from the rural domains, as set forth by the preceding diagrams.

The two phenomena are above all perceptible at the end of the $18^{th}$ century, from 1760 to 1789; the rise in prices being very general at that time. On the contrary, during the first half of the $18^{th}$ century (1700 to 1750), the decline in the revenues derived from landed property coincides with a fall in the prices of all the principal agricultural products.

It is probable that, independently of the other causes which acted on the price of land and agricultural produce, the increase or diminution of the buying power of the precious metals (gold and silver), exercised a great influence on the variations in prices. The same phenomena were observed both in England and Germany at the same periods.

## DIAGRAM No. III

This figure shows the variations in the prices of wheat, flour and bread, in France. It is destined to explain to the pupils, in the clearest possible manner, the relations existing between the prices of these three articles. M^r Zolla, for the tracing of these curved lines, has made use of French official statistics, and of the works of a French Economist, M^r Léon Donnat. — The influence exercised in 1887 by the higher duties on foreign corn is, in particular, worthy of notice.

## DIAGRAM No. IV

This figure sets forth the variations in the prices of beef and mutton at the Villette Meat Market.

M^r Zolla has, at the same time, traced the curves showing the prices of hay. It is well known that the price of meat is lower during the years when crops are bad, and in consequence fodder dear; the farmers, being no longer able to feed their cattle, are obliged to sell them, and these forced sales determine a fall in the price of meat. To give an example, this is what happened in 1888, and 1892. On the contrary when hay is abundant, and therefore low-priced, the farmers can keep their cattle, and the price of meat rises. — In 1890 and 1891, particularly, it will be seen that the fall in the prices of hay coincides with a rise in the price of meat.

1.342 — PARIS. — IMP. P. DUBREUIL, 18 & 18 BIS, RUE DES MARTYRS.

# CHLORURE D'ÉTHYLE

Le Kilo. **22** Francs.

**Prix du Siphon en verre de 1 litre 4 fr., de 2 litres 5 fr.**

## OXYGÈNE COMPRIMÉ, AZOTE COMPRIMÉ

**Notice spéciale.**

## NOUVEAU FILTRE-PRESSE DE LABORATOIRE DE L. LEFRANC

Prix : **48** Francs.

**Permettant de faire rapidement, sans installation, tous les essais de Laboratoire.**

*(Appareil fourni au Collège de France, à la Sorbonne, à l'Institut Agronomique, à la Faculté des Sciences, etc.)*

Description dans les Petites inventions de la *Nature* du 1er Août 1891. **Notice spéciale.**


## TURBINE DE LABORATOIRE

**Marchant par l'eau, pouvant donner jusqu'à 6 kilog.; petit modèle, 42 fr.; grand modèle, 58 fr.**

*Appareil fourni au Collège de France, à la Sorbonne, aux Facultés de Médecine de Paris et Bordeaux, aux Facultés des Sciences de Poitiers, Lyon, etc.*

**(Plus de 500 appareils fournis.)**

L'installation de cet appareil est nulle, un morceau de caoutchouc permet de le relier à n'importe quel robinet.

Voir la *Nature* du 15 Août 1891. **Notice spéciale.**

**Support à poulie mobile, permettant de transmettre le mouvement de la Turbine dans toutes les directions.**

Prix : **18** Francs.

## ENCRE F. H POUR ÉCRIRE SUR LE VERRE

On trempe une plume de fer dans le flacon de gutta-percha, et sur le verre bien nettoyé on écrit comme d'habitude ; quelques instants après on lave à l'eau pour empêcher les bavures, on a ainsi nettement en gravure les indications que l'on veut conserver.

S'emploie pour marquer les flacons, jauger les ballons et noter les indications sur les plaques photographiques (sans danger pour les mains ou les étoffes).

Prix du Flacon : **2** Francs.

## CRAYONS DE COULEURS POUR ÉCRIRE SUR LA PORCELAINE ET LE VERRE

La Pièce : **0** Fr. **40**

## MODÈLES DE CRISTAUX MONTRANT LES AXES

Voir la *Nature* du 12 Mars 1892.

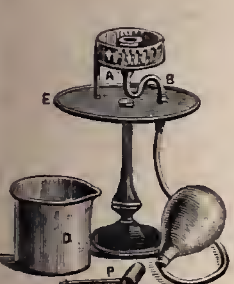
### NOUVEAU PERCE-BOUCHON

En quelques secondes on peut percer les plus gros bouchons de liège ou de caoutchouc, 12 grosseurs de trous (de 3 m/m à 25 m/m) *(Note spéciale)*.

## ESSOREUSE F. H POUR SÉPARER LES PRÉCIPITÉS, NOUVEAU MODÈLE

Cette essoreuse peut marcher soit à la main soit avec la petite turbine et tourner avec une vitesse de 1800 tours à la minute.

Prix : **65** Francs.



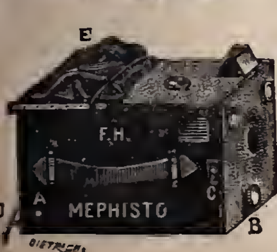
# L'HÉLIOS

Lampe au magnésium, permettant de photographier les intérieurs **(La plus puissante de toutes.)**

**Energie graphique 100,000 rads. Durée de l'éclair 15/100 de seconde. Rendement graphique 10 megags.**

Prix : **20** Francs.

Voir la *Nature* du 23 Janvier 1892. **Notice spéciale.**




# LE MÉPHISTO

Nouvel appareil à main, très léger, très portatif, avec magasin à escamoter pour 12 plaques $9 \times 12$, objectif extra rapide, obturateur permettant la pose ou l'instantané, 2 viseurs, un marqueur, appareil garanti.

**NOTICE POUR L'EMPLOI**

**Plus de 400 Appareils vendus en 6 mois. — Prix 48 Francs.**

**Nous sommes entièrement à la disposition de nos clients pour leur fournir aux meilleures conditions tous les appareils et instruments de Laboratoires.**

**Il suffit de nous indiquer les catalogues français ou étrangers dans lesquels ils figurent.**

Envoi franco sur demande des Catalogues de Produits chimiques, d'Electricité, d'Histoire naturelle.

**En préparation Catalogue illustré de Photographie.**

Compiègne. — Imprimerie HENRY LEFEBVRE, rue Solferino, 31.

# J. FRIBOURG & HESSE

J. FRIBOURG, Ingénieur des Arts et Manufactures

**FABRIQUE DE PRODUITS CHIMIQUES POUR LES SCIENCES ET L'INDUSTRIE A AUBERVILLIERS**

Produits et Appareils pour les *Laboratoires*, l'*Électricité* et la *Photographie*.

**Fournisseurs du Collège de France, de l'École Normale supérieure, de l'École polytechnique, de la Sorbonne, de la Faculté de médecine, du Muséum d'histoire naturelle, de l'Ecole de physique et de chimie, des Lycées, Collèges, etc.**

Magasins et Ateliers, **26, RUE DES ÉCOLES, 26** (près l'Ecole polytechnique)

Adresse télégraphique : FRIBESSE, PARIS — TÉLÉPHONE

## GAZ LIQUÉFIÉS OU COMPRIMÉS

# Chlore liquide

## ANHYDRE

Le chlore liquide est anhydre, il est contenu dans un siphon spécial résistant qui permet de le placer dans tous le laboratoires *sans danger*, sans fuite. Les récipients sont tous essayés et garantis résistant à plus de 50 atmosphères.


Un robinet spécial système **Jolly et Fribourg**, permet d'obtenir d'un côté le chlor gazeux, de l'autre le chlore liquide.

Le gaz se règle à volonté au moyen d'une petite clef permettant le dégagement bulle bulle ou le courant le plus intense.

Le siphon en fer forgé est de la contenance de 4 litres, il contient 4 kilos de chlor le poids du siphon est de **8 kilos,** sa hauteur est de 0,60 et sa largeur est de 0,14.

Le mode d'emploi est des plus *simples*, un *léger* mouvement de la clef permet de condui le chlore dans l'appareil où il doit agir.

**Prix du Chlore liquide, le Kil. 4 Francs.**

Par quantité de 4 kilos.

~~*(Prix spéciaux par 100 kilos.)*~~

Le chlore liquide rend les plus grands services dans tous les laboratoires, pour analyses métallurgiques, les préparations organiques, la démonstration dans les cours. pureté absolue, son état de siccité complète permet de l'employer sans aucun appare intermédiaire. Fabriqué industriellement, il est fourni à un prix inférieur à celui auquel revient dans les laboratoires.

**Le Siphon est loué pour un mois maximum au prix de 6 fr.; passé ce délai il est facturé au prix de 55 fr.**

*(Notice spéciale avec chaque Appareil)*

On peut voir fonctionner ces Appareils :

Au Laboratoire de M. Schutzemberger, au Collège de France. Au Laboratoire de M. Friedel, à la Sorbonne. Au Laboratoire de M. Joly, à l'Ecol Normale. Au Laboratoire de M. Etard, à l'Ecole de physique et de chimie, et dans nos Magasins.

# AMMONIAQUE LIQUIDE

## ANHYDRE

Le Kilo. **8** Francs.

Par Récipient minimum de 5 kilos.

**Le Récipient est loué à raison de 5 fr. par mois, pour un mois maximum ; passé ce délai il sera facturé 55 fr.**

## ACIDE CARBONIQUE LIQUIDE

### ANHYDRE

Le Kilo. **2** Fr.

Récipient de 8 kilos — sans location pendant un mois.

prix du Récipient: **65** fr.

## ACIDE SULFUREUX LIQUIDE

### ANHYDRE

Le Kilo. **2** Fr. **50**

Récipient en verre de 1 litre, 4 fr.; Récipient en verre de 2 litres, 5 fr.

# CHLORURE DE MÉTHYLE

Le Kilo. **7** Fr. **50**

**Le Récipient en cuivre est loué pour 15 jours au prix de 5 francs. Récipient de 1 kilo., avec pulvérisateur pour l'emploi médical. Passé ce délai, il sera facturé 35 fr. sans pulvérisateur ; 66 fr. avec pulvérisateur.**

**Le Chlorure de Méthyle se livre également en siphons de 3 et 10 kilos.**

# FABRIQUE DE PRODUITS CHIMIQUES

POUR LES LABORATOIRES, LES ARTS ET L'INDUSTRIE

**USINE : 11, Rue de la Gare, AUBERVILLIERS**

# J. FRIBOURG & HESSE

J. FRIBOURG, Ingénieur des Arts et Manufactures

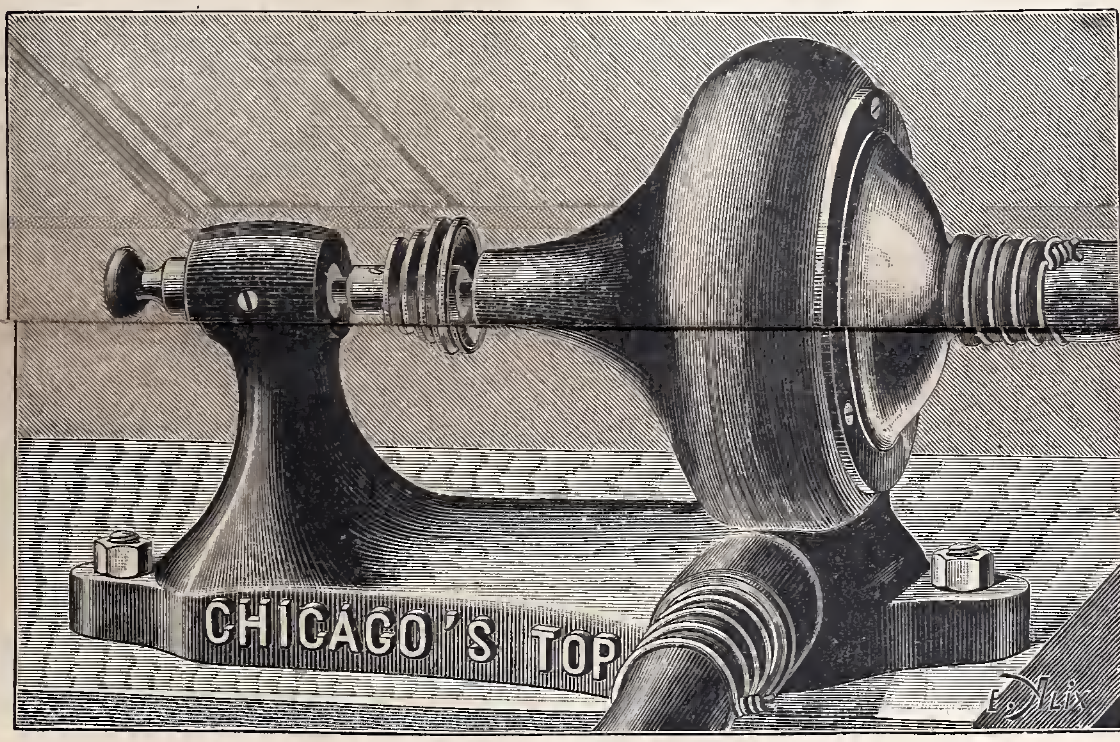
FOURNISSEURS DU COLLÈGE DE FRANCE, DE LA FACULTÉ DES SCIENCES, DE FACULTÉ DE MÉDECINE, DE L'ÉCOLE POLYTECHNIQUE, ETC.

26, RUE DES ECOLES près la Rue de la Montagne-Sainte-Geneviève, PARIS

Adresse télégraphique : **FRIBESSE — PARIS** — TÉLÉPHONE

Appareils de Laboratoire. — Instruments de précision. — Balances. — Appareils de physique. — Photographie
Électricité. — Verrerie ordinaire et graduée.
Verrerie soufflée. — Porcelaines, Terres et Grès. — Produits spéciaux pour l'industrie.

## TURBINE A EAU, Brevetée S. G. D. G.




| GRAND MODÈLE | | | | PETIT MODÈLE | | | |
|---|---|---|---|---|---|---|---|
| Hauteur | Largeur | Longueur | Poids | Hauteur | Largeur | Longueur | Poids |
| 0m,21 | 0m,16 | 0m,26 | 7 kos | 0m,15 | 0m,16 | 0m,25 | 3 kos500 |

Le moteur que nous présentons a été spécialement étudié et construit pour les laboratoires de chimie, les cabinets de physique et les ateliers d'amateurs. Il fonctionne à toutes les pressions ; l'eau dont on dispose dans les appartements suffit pour actionner l'outillage d'amateurs : tours, scies, perceuses, lapidaires, polissoirs, etc.

**DESCRIPTION.** — L'appareil, d'une extrême simplicité, se compose de trois pièces principales : **la carapace** en fonte qui forme l'enveloppe et le bâti de la machine, la **roue motrice** composée d'un plateau portant douze aubes en acier et d'un arbre en acier sur lequel est calée une poulie à trois gorges, enfin **la cloche distributrice** qui dirige l'eau sous pression sur les aubes de la turbine, par un ou plusieurs orifices suivant la force que l'on veut obtenir ; l'eau, après avoir travaillé, sort par un orifice placé à la partie inférieure de la carapace.

**INSTALLATION.** — La machine peut être placée sur une table voisine d'un robinet d'eau. Le liquide arrive dans la cloche en bronze par un tuyau en caoutchouc entoilé de 20 millimètres intérieur fixé sur l'ajutage de cette cloche par une ligature en fil de fer recuit ; l'écoulement par l'orifice inférieur doit toujours se faire très librement, pour que le liquide ne s'accumule pas dans la carapace et pour éviter que la roue ne tourne dans l'eau ; pour cette même raison l'eau doit toujours s'écouler vers un niveau inférieur à la base de la machine, si on emploie des tuyaux en caoutchouc éviter les angles qui occasionnent des rétrécissements.

Pour utiliser le travail de la machine qui doit toujours conserver une vitesse d'environ 2,000 tours pour fonctionner dans de bonnes conditions, on relie une des gorges de la poulie motrice à une autre poulie à gorge de **grand diamètre** (au moins 50 centimètres) par un lien **très flexible** (corde à violon ou ficelle) ; la force doit être prise sur l'**arbre** de la grande poulie ou sur une poulie de **petit diamètre** calée sur cet arbre ; on gagne ainsi en force ce que l'on perd en vitesse. Ce n'est que dans le cas des appareils demandant une grande vitesse et une force relativement faible que l'on accouple directement ou qu'on relie une des trois gorges à une poulie de dimension à peu près égale, mais jamais inférieure ; essoreuses, ventilateurs, dynamos, filtres à force centrifuge, etc.

**APPLICATION.** — Laboratoires de chimie : essoreuses, agitateurs, ventilateurs (à partir de 15 mètres de pression) ; machines électriques, statiques et dynamiques (à partir de 25 mètres) ; charge des accumulateurs pour analyses électrolytiques.

Laboratoires de physiologie : soufflets pour respiration artificielle (à partir de 25 mètres) ; filtres à force centrifuge (à partir de 20 mètres), etc.

Ateliers d'amateurs : tours (25 mètres) ; lapidaires, scies (30 mètres) ; perceuses (15 mètres).

PETIT MODÈLE. . . . . . . **42** Francs | GRAND MODÈLE . . . . . . **58** Francs

| PETIT MODÈLE | | | | GRAND MODÈLE | | | |
|---|---|---|---|---|---|---|---|
| CHUTES EN MÈTRES | DÉBITS EN LITRES à l'heure. | TRAVAIL UTILE en KILOGRAMMÈTRES sur l'arbre. | NOMBRE DE TOURS le plus avantageux à la minute. | CHUTES EN MÈTRES | DÉBITS EN LITRES à l'heure. | TRAVAIL UTILE en KILOGRAMMÈTRES sur l'arbre. | NOMBRE DE TOURS le plus avantageux à la minute. |
| 15 | 200 | 0k48 | 1.700 | 25 | 810 | 2k | 2.200 |
| 20 | 240 | 0.66 | 2.000 | 30 | 885 | 2.6 | 2.400 |
| 25 | 270 | 0.80 | 2.200 | 35 | 900 à 1.600 | 3k à 6k | 2.600 |
| 30 | 295 | 0.96 | 2.400 | 40 | 1.000 à 1.550 | 3.3 à 6 | 2.800 |
| 40 | 340 | 1.34 | 2.800 | 45 | 1.100 à 1.450 | 3.7 à 6 | 2.900 |
| 45 | 360 | 1.50 | 2.900 | 50 | 1.200 à 1.400 | 4.3 à 6 | 3.000 |
| 50 | 360 | 1.75 | 3.000 | 60 | 1.300 à 1.350 | 5.5 à 6 | 3.300 |
| 60 | 360 | 2.00 | 3.300 | 70 | 1.300 | 6 | 3.600 |
| 100 | 200 | 2.00 | 4.400 | 100 | 700 | 6 | 4.400 |

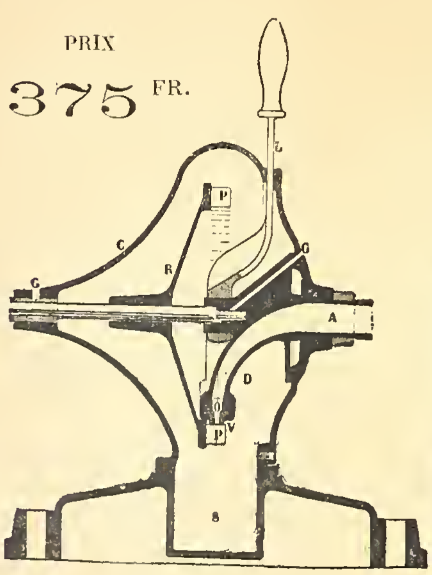
**Laboratoires pourvus de nos moteurs :** Collège de France, Facultés des sciences de Paris, Lyon, Toulouse, Faculté de médecine, Muséum, Hôpital Saint-Louis, bureau de vérification des alcoomètres, etc., laboratoires des Universités étrangères (Louvain, Vienne).

*En construction :* appareils spéciaux pouvant fonctionner avec notre turbine (essoreuses, ventilateurs, agitateurs pour secouer les flacons, machines statiques, etc.).

## MODELE INDUSTRIEL

PRIX

375 FR.




Ce nouveau type dont la puissance varie de 1/4 à 1 cheval suivant le débit et la hauteur de chute est pourvu d'un distributeur à orifices variables manœuvré par le levier L et permettant d'ouvrir successivement 1, 2, 3, 4, 5, 6 orifices et de rendre ainsi la dépense proportionnelle au travail. Ce modèle s'accouple directement aux dynamos et utilise l'énergie que possède l'eau sous pression distribuée aujourd'hui à domicile dans toutes les villes.

| 1/4 DE CHEVAL | | 1/2 CHEVAL | | 1 CHEVAL | |
|---|---|---|---|---|---|
| CHUTES en mètres. | DÉBITS en litres à l'heure. | CHUTES en mètres. | DÉBITS en litres à l'heure. | CHUTES en mètres. | DÉBITS en litres à l'heure. |
| 25 | 3.600 | 25 | 7.200 | 25 | 14.400 |
| 40 | 2.200 | 40 | 4.450 | 40 | 9.000 |
| 50 | 1.750 | 50 | 3.550 | 50 | 7.200 |
| 100 | 850 | 100 | 1.750 | 100 | 3.600 |

**Nous nous chargeons d'effectuer les modifications ou constructions d'appareils qui nous seront demandés ; un atelier de mécanique, installé dans nos magasins, nous permet d'exécuter rapidement ces travaux.**

*Pour expériences ou renseignements, s'adresser en nos magasins*, 26, Rue des Écoles.

**Nouveaux Appareils de la Maison :** Syphon de chlore liquide, filtre-presse de laboratoire, appareils photographiques instantanés : le Méphisto, le Niepce ; nouvelle lampe au magnésium : l'Hélios ; papier kallystotype, etc.

NOTICES SUR DEMANDE

Compiègne. — Imprimerie HENRY LEFEBVRE, rue Solferino, 31.

# J. FRIBOURG & HESSE

J. FRIBOURG, Ingénieur des Arts et Manufactures

FABRICANTS DE PRODUITS CHIMIQUES & APPAREILS POUR LABORATOIRES, PHOTOGRAPHIE, ÉLECTRICITÉ

**Fournisseurs des Ministères, des Écoles supérieures, des Facultés, etc.**

**PARIS — 26, RUE DES ÉCOLES, 26 — PARIS**

# PAPIERS A FILTRER

## NOUVEAU PAPIER BERZÉLIUS FRANÇAIS

MARQUE F. H.

**Nous recommandons ce Papier, fabriqué spécialement pour nous sur nos indications, par les grandes Papeteries du Pont-de-Claix, pour tous les travaux de Laboratoires qui exigent de la rapidité et des soins.**

**La Main. . . . . . 0 90 — La Rame . . . . . 15 » — Par 10 Rames. . 13 »**

L'échantillon du Papier ci-joint est du BERZÉLIUS FRANÇAIS F. H.

### PAPIER A FILTRER ORDINAIRE

QUALITÉ COURANTE

Blanc . . . . . . . . . La Main : **0 70** — La Rame : **12** »
Gris. . . . . . . . . . La Main : **0 60** — La Rame : **10** »

### PAPIER A FILTRER PLISSÉ A LA MAIN

En Paquets de 100 filtres (Papier blanc).

| | | | | | |
|---|---|---|---|---|---|
| Nº 0. | 13 % de diamètre pour entonnoir de | 30 gr. | Le cent. | 1f 15 |
| 1. | 15 — — | 50 | — | 1 30 |
| 2. | 19 — — | 100 | — | 1 40 |
| 3. | 25 — — | 250 | — | 1 65 |
| 4. | 33 — — | 500 | — | 2 30 |
| 5. | 40 — — | 1 lit. | — | 2 75 |
| 6. | 45 — — | 1 1/2 | — | 3 30 |
| 7. | 50 — — | 2 lit. | — | 3 75 |

### PAPIER BERZÉLIUS SUÉDOIS

Qualité supér. 1 F. . La Main : **3** » — La Rame : **60** »
Qualité ordin. 1 B. . La Main : **2 75** — La Rame : **55** »

### PAPIER A FILTRER CHIMIQUEMENT PUR

Pour Analyses quantitatives, lavé aux acides chlorhydrique et fluorhydrique.

| | | | |
|---|---|---|---|
| Nº 589 en disques de | 5 cent. 1/2 de diamètre . . . | Le Mille. | 22f » |
| — | 7 — — . . . | — | 24 » |
| — | 9 — — . . . | — | 35 50 |
| — | 11 — — . . . | — | 43 » |
| — | 12 — 1/2 — . . . | — | 45 » |
| — | 15 — — . . . | — | 57 » |

Ces filtres sont en paquets de 100 et sur chaque paquet est inscrit le poids des cendres.

## NOUVEAU FILTRE-PRESSE DE LABORATOIRE

### DE L. LEFRANC

**Permettant de faire rapidement, sans installation, sans machines, tous les essais de Laboratoire.**

*L'appareil est en ébonite pour résister aux acides. Il peut, du reste, être construit en une matière quelconque (bronze, fonte, étain, etc.).*

*La matière à filtrer arrive par un entonnoir à 1 m. 50 ou 2 m. du filtre, donnant ainsi une pression suffisante pour la plupart des essais.*

### PRIX :

Sans pied . . . . . . . . . . . . . . . . . . **35f** »
Avec pied . . . . . . . . . . . . . . . . . . **40** »
Complet (avec support et entonnoir) . . . . . . . . . **48** »

On peut employer le vide pour aspirer par les tubulures inférieures, ou la pompe de Gay-Lussac pour agir sous pression et se rapprocher des conditions industrielles. (Voir la notice spéciale.)

### COTON DE VERRE

**Produit spécial de fabrication française pour FILTRATION D'ACIDES ou de tout autre liquide ne permettant pas l'emploi du papier.** Qualité extra, le kilog. . . . . . . . . . . . **65** »

**TISSUS** pour filtrations en coton, poils de chèvre, amiante, etc.

**CHAUSSES** en feutre.

**PAPIER SPONGIEUX** pour sirops.

Nous sommes entièrement à la disposition de nos Clients pour leur fournir aux meilleures conditions, tous les **Produits chimiques, Ustensiles de Laboratoires** et **Instruments de Sciences** dont ils peuvent avoir besoin.

Envoi *franco* sur demande du **Catalogue de Produits chimiques** et du **Catalogue d'Électricité**.
*Sous presse :* **Catalogue de Photographie.** — *En préparation :* **Catalogue de Verrerie et Instruments.**

**CHLORE LIQUIDE ANHYDRE : 4 fr. le kilo** (Notice spéciale sur demande).

**TURBINE DE LABORATOIRE, pouvant donner jusqu'à 6 kilogrammètres**

Petit modèle . . . . . . . **42** » — Grand Modèle. . . . . . . **58** »

Compiègne. — Imprimerie HENRY LEFEBVRE, rue Solferino, 31.

## IMPORTANT TO DISTILLERS!

# Continuous Rectification of Alcohol*

Every distiller of the country is interested in three facts:

1st. The economic production of high-grade (96°) alcohol at one operation.

2d. Doing away with year's storage; which means insurance and very little return upon idle capital.

3d. Selling his product within a few months after it is made, at a market rate that would have been realized only years later.

**A Specialty of Building** Industrial and Agricultural Distilleries for all substances from which alcohol may be produced.

**Defy Competition.** 1st. In the continuous rectification of alcohol. 2d. Continuous clarification of low wines. 3d. In distillation by the use of columns known as Pasteurizators, producing in one operation pure rectified alcohol at 96°.

The Barbet apparatus for the continuous rectification of alcohol was awarded gold medal at several exhibitions, and has met with great success in Spain, Brazil, West Indies (medal of honor at Paris Exhibition of 1890; prize in the competition test for best method of rectification of alcohol; medal awarded by the Agricultural Society of France), etc. By it is accomplished in a physical way, without chemicals, what has not hitherto been thought possible.

In a single operation, followed by three months' keeping in warehouse, a liquor is obtained equal to ten-year-old whiskey or brandy. The rights for American patents have not yet been disposed of. Before making contracts be sure that the apparatus is genuine.

Full information may be obtained from inventor.

EMILE BARBET,
Engineer and Chemist, Editor of *Alcool et Le Sucre;*
76 Rue d'Assas, Paris.

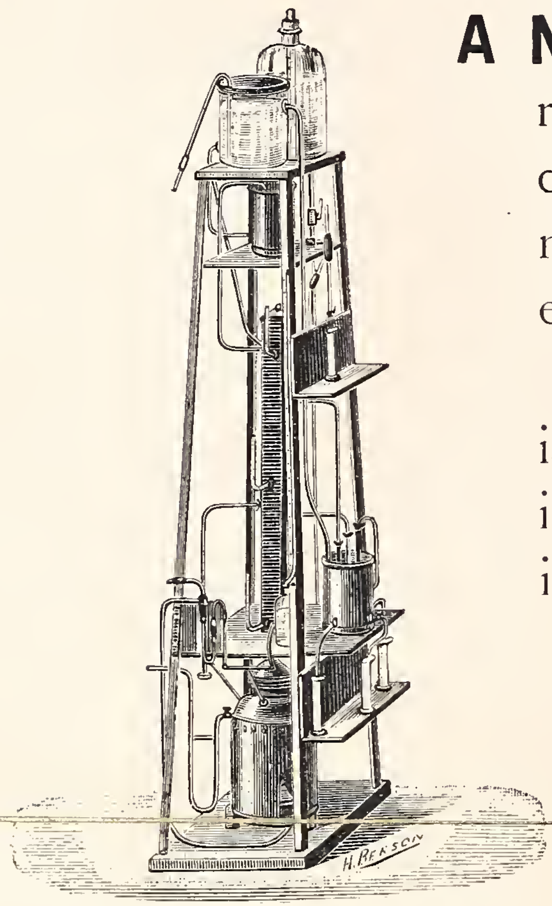
American Patents 436,684 and 436,764.

Capitalists Take Notice.—A beet-sugar factory working 250 tons of beets per diem demands a capital of at least $300,000.

No risks should be taken unless there is a certainty as regards results. Analyses of beets cultivated upon different plots of land are often misleading. By working hundreds of tons of beets for alcohol, a very accurate idea may be obtained of their percentage of sugar. On well-organized beet-sugar estates there should be a distillery attached, wherein the residuum molasses is utilized.

*See description in *The Sugar Beet,* August, 1890.

# Laboratory Rectification of Alcohol




Barbet Laboratory Apparatus.

**A New Apparatus** for all kinds of investigations relating to fermentation, distillation and rectification of alcohol. The results obtained permit accurate comparisons between this and any existing distilling process.

The Barbet Universal Laboratory Apparatus is the only one giving same results as obtained in the best types of distilling columns now used in the United States.

In one operation there may be obtained:

1st. A pure alcohol 96°.7*.

2d. Clarification of any low wine.

3d. A fractional separation of all impurities and natural aromas.

It is interesting to note that 100 cubic feet of ordinary gas will give sufficient caloric for the rectification of one gallon of alcohol (calculated on the basis of 100° pure) by the Barbet Apparatus.

| | | Continuous | Non-Continuous |
|---|---|---|---|
| Cost. | Type No. 1, production one pint per hour | $140 | $110 |
| | " No. 2, " two quarts per hour | 180 | 145 |
| | " No. 3, " five quarts " | 280 | 220 |

These prices include iron frame and supports, all tubes, glass, copper, etc., and all testing appliances. The Barbet Laboratory Apparatus is tested before shipping. Packing six per cent. additional, delivered in Paris, cash in advance ; no discounts allowed on delivery. Transportation at expense of purchaser.

*The results obtained by other well-known Laboratory Apparatus are as follows:

| | Maximum |
|---|---|
| Claudon and Morin | 94°.1 |
| Le Bel and Henninger | 94°.1 |
| Saralle | 92°.5 |
| Winssinger | 88°.0 |

See *Revue de Chemie Industrielle* for December, 1893.

# J. FRIBOURG & HESSE

J. FRIBOURG, Ingénieur des Arts et Manufactures

FABRICANTS DE PRODUITS CHIMIQUES & D'APPAREILS DE LABORATOIRE

26, RUE DES ÉCOLES (près l'École Polytechnique), PARIS

Usine à AUBERVILLIERS, 11, Rue de la Gare

Ver atteint par le botrytis ; aspect 4 à 5 jours après la mort.

## TUBES J. FRIBOURG & HESSE

POUR LA

# DESTRUCTION DU VER BLANC

Les travaux récents présentés à l'Académie des Sciences par MM. Prillieux et Delacroix, de l'Institut National Agronomique de Paris, et par M. Giard, professeur à la Sorbonne, ont établi qu'il existe un champignon parasite du ver blanc (larve du hanneton) qui détruit cet insecte.

On a remarqué que dans les champs où était signalée la présence du parasite, les vers blancs mouraient, tandis que les cultures reprenaient toute leur vigueur.

Le parasite n'attaque que le ver blanc et est inoffensif pour les autres animaux.

Nous inspirant des savantes méthodes de M. Pasteur, nous avons entrepris la production artificielle du champignon parasite *Botrytis tenella* sur une vaste échelle.

Nous offrons à l'Agriculture des spores contenues dans des tubes, à l'aide desquelles il lui sera possible d'utiliser cette découverte.

Nos cultures, conduites avec le plus grand soin par des bactériologistes expérimentés dans les appareils scientifiques les plus perfectionnés, sont **garanties** capables de communiquer la maladie parasitaire à plusieurs centaines de vers.

Nous indiquons ci-dessous le **mode d'emploi** de nos tubes et nous recommandons de s'y conformer très-exactement.

### MODE D'EMPLOI

1° Prendre une terrine plate, la tapisser d'une couche de terre d'environ un centimètre (assez peu profonde pour que les vers ne puissent s'y cacher) l'imbiber légèrement d'eau et y déposer une centaine de vers blancs, veiller à ce que la terrine soit assez grande pour que les vers ne se heurtent pas les uns contre les autres, et ne se blessent pas avec leurs pinces. Il est de la plus haute importance que les vers ne meurent pas de mort naturelle pendant la durée du traitement par les spores du *Botrytis tenella* ;

2° Battre un blanc d'œuf dans environ 30 cc. d'eau ; y verser le contenu du tube et l'y mélanger ; répandre le tout sur les vers blancs, soit en les aspergeant, soit, de préférence, en touchant chaque ver près de la tête, au moyen d'un pinceau et sur les côtés ;

3° Recouvrir la terrine de planches sur lesquelles on met de la mousse mouillée et l'enterrer dans un endroit frais à l'ombre ;

4° Au bout d'environ 10 heures, les vers sont atteints de la maladie. On les prend un à un, toujours avec assez de précaution pour ne pas les endommager ni les blesser, et on les disperse dans les diverses parties du terrain, à environ 20 centimètres de profondeur dans le sol. On les recouvre de terre. Choisir de préférence les endroits les plus attaqués par les vers blancs.

Prix du Tube **FRIBOURG & HESSE : 6** Francs

des Tubes de Culture pour essais . . . . . . 0 Fr. 75

RABAIS PAR QUANTITÉS

**DIPLOME D'HONNEUR A L'EXPOSITION DES INSECTES, PARIS 1891**

Brochure explicative sur le nouveau moyen de détruire les VERS BLANCS et les HANNETONS par le BOTRYTIS TENELLA. — Prix : **50** centimes.

Compiègne. — Imprimerie Henry Lefebvre, rue Solferino, 31.

*Extrait de*

# L'ALCOOL ET LE SUCRE

REVUE MENSUELLE ILLUSTRÉE

# APPAREIL UNIVERSEL
## POUR LABORATOIRES

*Rectification discontinue et continue, Distillation continue avec sélection des divers produits*

Nos lecteurs nous rendront la justice que depuis la fondation de ce journal nous nous sommes toujours rigoureusement abstenu de la moindre allusion à nos procédés personnels de Rectification ou de Distillation continue, marquant par là notre ferme volonté de conserver à la nouvelle Revue une allure absolument impersonnelle et éclectique. Nous ne faillirons pas à la tâche qui nous a été confiée. Mais, si loin que nous poussions nos scrupules à ce sujet, nous ne croyons pas encourir de reproche en parlant aujourd'hui, non pas d'un appareil industriel, mais d'un appareil scientifique qui présente un caractère incontestable de nouveauté, car il vient de nous permettre d'atteindre en laboratoire à 96°,7, force réelle à 15°, résultat qu'on n'avait encore jamais obtenu avec des instruments de ce genre.

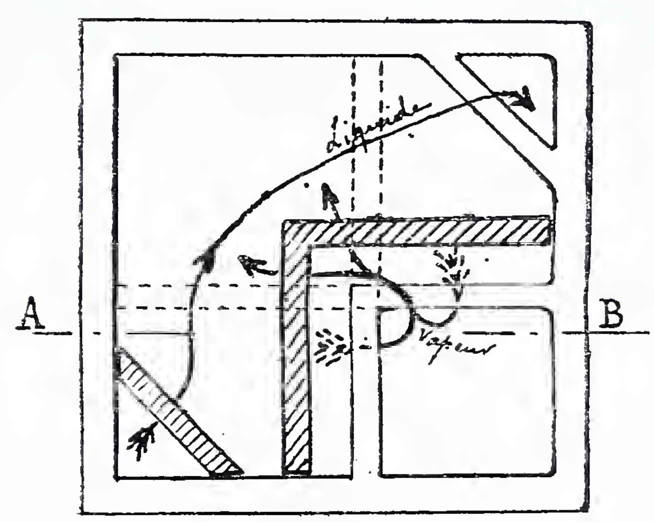
La Planche VIII donne deux vues de cet instrument. S'il paraît un peu compliqué au premier abord, c'est parce qu'il est habillé de toute la tuyauterie nécessaire pour fonctionner en Distillation ou Rectification continue, avec extractions simultanées des diverses impuretés de tête et de queue ou arrière-queue. Mais réduit à la fonction de rectificateur discontinu, il n'est que la reproduction fidèle, en miniature, de tous les rectificateurs classiques que chacun connaît.

Sa seule innovation, à ce point de vue, consiste dans la forme des plateaux, dont nous donnons ici le dessin.

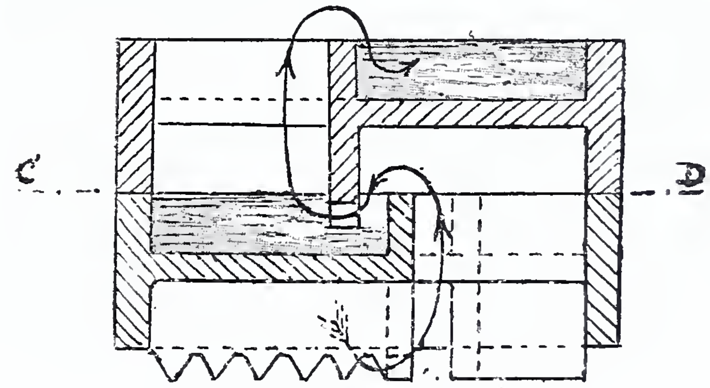
On connait notre théorie sur la rectification des alcools ; la voici en deux mots : Ce sont les plateaux des rectificateurs qui sont le véritable siège de l'affinage des produits. Les condenseurs, improprement appelés analyseurs, n'ont qu'un pouvoir presque nul pour opérer des sélections par ordre de volatilité. Leur vrai rôle consiste à fournir d'une façon automatique un liquide alcoolique destiné à laver les vapeurs alcooliques ascendantes ; la perfection du lavage dépend en première ligne de sa méthodicité, c'est-à-dire du nombre et de la forme des plateaux de rectification, en même temps que du volume proportionnel de la rétrogradation.

Jusqu'à présent tous les appareils de laboratoire exagéraient les condensations, pour tâcher de diminuer le nombre des plateaux. Il paraissait difficile de construire ceux-ci d'une façon assez simple pour pouvoir les multiplier comme dans l'industrie. C'était pourtant la seule méthode rationnelle pour arriver à des résultats analogues, et c'est en vue de cette solution que nous avons concentré nos efforts.

L'appareil représenté planche VIII possède 45 plateaux distincts, et l'on pourrait encore en ajouter facilement une quinzaine sans atteindre une hauteur exagérée pour un laboratoire ; actuellement le 45ᵉ plateau est à peu près à $1^m,55$ au dessus du sol, pas davantage, et l'appareil avec bac à eau et flacon à vin a une hauteur totale de $2^m50$.

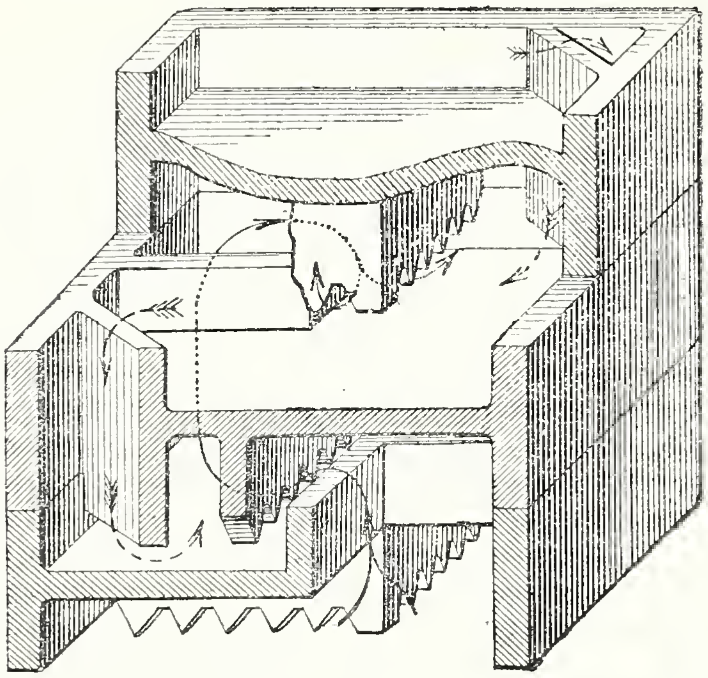



Les plateaux sont carrés et n'ont que 5 centimètres de côté, ils sont tous pareils et indépendants ; on en fait le montage en les tournant alternativement d'un demi-tour. Ils ne possèdent aucun organe rapporté, de sorte que le tout est d'un ajustage facile et permet d'atteindre une grande

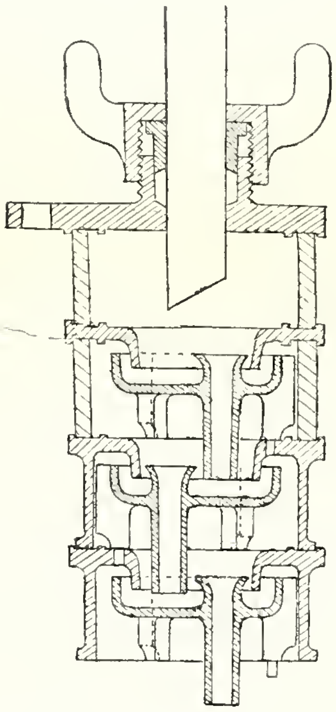



précision mécanique. Chaque plateau, après ajustage, est étamé avec soin à l'étain fin, et le joint avec les plateaux voisins se fait par soudure à l'étain. On obtient ainsi une

colonne en un seul bloc facile à monter au laboratoire et d'une étanchéité parfaite.



Cette construction simple, précise et solide constitue un avantage marqué sur le modèle que nous avions antérieurement adopté et que nous avons décrit en 1890 dans notre ouvrage sur les Appareils de Distillation et de Rectification (pages 187 et suivantes). Nous en reproduisons ici le dessin.



Le volume du liquide sur chaque plateau était très réduit, ce qui est une condition essentielle pour arriver à un bon résultat ; mais le montage de cette colonne, avec doubles joints au papier enduit de céruse, était extrêmement délicat et laborieux.

Le nouveau modèle est bien plus simple et exige encore moins de hauteur pour chaque plateau. Il a aussi le mérite de contenir extrêmement peu de liquide. Donnons une courte description de l'ensemble de l'appareil, en ne nous occupant, pour le moment, que de la rectification discontinue.

B est la chaudière en cuivre, étamée intérieurement, d'une capacité de 10 litres. Elle est surmontée d'un chapiteau C, relié à la colonne à plateau au moyen d'un joint conique rodé, serré par l'écrou O. La colonne à plateaux repose sur la tôle S, et la chaudière se trouve suspendue à la colonne; on rapporte après coup les 3 cales en bois *a* pour soutenir l'ensemble du fourneau en tôle A et de la chaudière. Cette disposition permet de dégager la chaudière pour la vider et nettoyer si l'on veut, sans avoir à toucher quoi que ce soit de la partie supérieure de l'appareil.

Au dessus de la colonne à plateaux D E se trouve un petit condenseur tubulaire, à tubes d'étain (F), et la vapeur alcoolique non condensée se dégage par le tuyau N° 6 pour aller au réfrigérant R. Celui-ci est agencé pour opérer notre réglage invariable et automatique du coulage horaire. A cet effet l'extrémité inférieure du serpentin est rattachée à une bouteille en verre (N° 7) qui permet d'apercevoir le coulage. La bouteille est surmontée d'un tube d'air *t*, et munie d'un tube inférieur et d'une tubulure latérale oblique. Au bas un robinet (N° 8) règle le coulage au taux que l'on veut ; l'alcool coule dans une éprouvette graduée grâce à laquelle on ouvre le robinet de la quantité nécessaire pour obtenir par chaque cinq minutes le nombre de centimètres cubes que l'on désire.

L'excédant de l'alcool sort de la bouteille par la tubulure oblique, qui sert de trop plein, et rentre par le tuyau siphon N° 9 au haut de la colonne.

Les joints *d* sont faits de la façon spéciale que nous avons déjà décrite ailleurs : les deux tubes sont rapprochés à contact. On enroule une petite bande de papier parcheminé, et l'on serre énergiquement celle-ci au moyen d'une bande de caoutchouc souple qui assure l'étanchéité sans que l'alcool ait contact de la gomme.

L'introduction dans la chaudière du flegme à rectifier peut se faire par la tubulure N° 4 qui est assez large précisément dans ce but; la vidange se fait par un siphon de caoutchouc si l'on ne veut pas démonter la chaudière.

La tubulure 4, une fois remise en place, a un double emploi. A droite elle communique la pression de la chaudière à un flacon M dans lequel plonge un tube manométrique M' fixé le long d'un des montants en cornières Q. L'opérateur voit ainsi la pression de marche qui convient le mieux au genre d'essai qu'il fait.

A gauche le tuyau 4' communique la pression à un régulateur du gaz K *à régime variable.* Le chauffage est fait par un simple bec Bunsen, muni de son champignon, et la dépense du gaz est si réduite qu'il suffit d'une pression de 25 millimètres d'eau pour donner la chaleur voulue. La pression de la chaudière (de 40 à 50 c/m d'eau) fait monter le mercure dans la bouteille de gauche ; le mercure étrangle plus ou moins le passage du gaz et opère ainsi la régulation du chauffage. Si l'on veut augmenter la pression, l'on tourne la vis V de façon à augmenter la dénivellation des deux bouteilles à mercure, qui sont reliées par un tuyau en caoutchouc. La pression dans la chaudière se maintient ainsi d'une façon parfaite, et les écarts ne dépassent pas un centimètre d'eau dans le tube M'.

Nous avons donc assuré déjà la régularité absolue du coulage et celle du chauffage. Reste celle de l'eau au condenseur.

Dans ce but, il est bon d'interposer entre la conduite d'eau du laboratoire (qui est toujours sous forte pression) et le condenseur, un véritable bac à eau à niveau constant. C'est la conserve en verre J qui remplit ce rôle. On y amène l'eau froide par un tube de verre ou de caoutchouc, et l'on s'arrange pour que le trop-plein (tuyau N° 19) fonctionne tout le temps. Au bas se trouve une tubulure avec bouchon en caoutchouc à 2 orifices. De l'un d'eux part un tube de verre avec tuyau de caoutchouc (N° 18) se rendant au bas du condenseur F ; le débit de l'eau est réglé par une pince à vis P', qui est d'une grande sensibilité. L'eau chaude sort par le tuyau N° 22.

On voit que cet appareil n'a rien à envier aux appareils

industriels les plus perfectionnés ; sa colonne possède même trois thermomètres (T, T' et T") qui permettent à tout instant de se rendre compte de la richesse alcoolique des plateaux supérieurs, moyens ou inférieurs. Aussi la docilité de ce rectificateur est-elle parfaite. Il nous a donné les résultats suivants :

| | | | |
|---|---|---|---|
| Coulage de | 375 c. c. à l'heure, | degré réel à 15° | 96°,7 |
| — | 450 — | — | 96°,6 |
| — | 630 — | — | 96°,5 |
| — | 1.200 — | — | 96°,3 |
| — | 2.400 — | — | 95°,2 |

On voit tout de suite par ces résultats comparatifs combien les derniers dixièmes de degré sont difficiles à décrocher, car le chauffage a été maintenu le même pour ces différentes allures. Cela prouve, ainsi que nous l'avons déjà fait remarquer dans notre ouvrage précité, que lorsqu'on compare la dépense de vapeur de deux rectificateurs industriels, il est indispensable de faire mention du degré exact (force réelle à 15°, et non pas le degré corrigé par les tables usuelles de la Régie) que possédait l'alcool pendant l'expérimentation. Faute de cette base, l'appréciation n'a aucune valeur.

Voyons maintenant l'agencement de l'appareil pour opérer en distillation continue à haut degré.

A toutes les régulations déjà obtenues, il fallait en ajouter une autre indispensable pour l'allure continue : la régularité d'alimentation, non seulement comme débit mais même comme température à l'entrée dans les plateaux. Car ceux-ci sont si petits et ont si peu de *volant de chaleur*, que l'on doit s'efforcer de ne pas leur emprunter quoi que ce soit, sous peine de tout troubler.

Le récupérateur de la chaleur des vinasses, que nous ne manquons jamais une occasion de recommander en industrie à cause de la grande économie qu'il procure, ne pouvait ici faire notre affaire, parce qu'il n'assure pas une régularité de température suffisante, surtout à la mise en route. En Laboratoire, ce n'est pas l'économie de combustible qui doit être la principale préoccupation ; ce qui prime tout c'est la commodité de marche de l'appareil, afin que l'opérateur obtienne facilement des résultats d'une grande netteté.

C'est à la chaudière elle-même que nous avons emprunté la chaleur qu'il nous fallait. Le vin froid entre par le robinet 1 dans un serpentin en étain logé dans le liquide de la chaudière, et ressort par le tuyau N° 2 pour aller au *plateau d'alimentation*. Le liquide de la chaudière a un volant de chaleur assez considérable, et une température suffisante pour amener le vin à ébullition, quand même on forcerait momentanément l'alimentation. Le régulateur à mercure K se charge de donner assez de gaz pour que la pression de la chaudière ne diminue pas.

La température de l'alimentation se trouve donc constante et égale à l'ébullition. Reste le débit.

Pour celui-ci, nous nous servons tout d'abord d'un flacon de Mariotte G. L'orifice supérieur est fermé par un bouchon muni d'un tube plongeur, par lequel rentrent les bulles d'air au fur et à mesure que le liquide s'écoule par le tuyau d'alimentation. On sait que la pression sur l'orifice de sortie se trouve constante et égale à la hauteur verticale entre cet orifice et le bas du tube plongeur. Une pince à vis P permet de régler le débit d'une façon à peu près invariable. Par surcroît de précautions, nous avons ajouté une bouteille de verre (N° 15) où l'on voit couler le liquide. La moindre variation inopinée du débit se trahit par la modification de la veine liquide ; l'opérateur est donc averti immédiatement et peut aviser.

La sortie automatique et continue des vinasses se fait par le siphon N° 3.

Si nous n'avions pour but que de faire de la distillation à haut degré, sans purification d'aucune sorte, notre description s'arrêterait ici. Mais nous n'admettons pas que l'on fasse de la distillation à haut degré sans en profiter pour extraire simultanément la majeure partie des impuretés de tête et de queue, attendu qu'il n'en coûte rien du tout, si ce n'est la peine de faire les diverses extractions là où se trouvent localisés les différents produits par la force même des choses.

Notre appareil peut reproduire exactement en petit nos grandes colonnes à distiller dite *à Pasteurisation et à extraction des huiles*.

Pour ne pas multiplier les prises d'eau froide et sorties d'eau chaude, nous avons installé un réfrigérant unique H à trois serpentins concentriques. Il est alimenté d'eau froide par le tuyau 19, c'est-à-dire par le trop plein du bac à eau J, car ici il n'est pas besoin de régulation, et un excédant d'eau ne peut nuire. L'eau chaude sort par le tuyau N° 20.

Le serpentin extérieur (N° 5) sert aux vapeurs de la chaudière B, à la fois pour contrôler l'épuisement des vinasses (déjà indiqué par le Thermomètre T") et surtout pour extraire les vapeurs parfumées, dans les cas où l'on distille des vins naturels aromatiques (vins, tafias, kirschs, cidres, etc). C'est là, en effet, comme nous l'avons démontré, que l'on trouve les essences végétales lourdes, d'un arôme agréable, à condition que l'on ait opéré la sélection des huiles amyliques nauséabondes et plus volatiles.

Celles-ci sont extraites par le robinet 11' quand on fait de la distillation continue, et par 11 quand on fait de la rectification continue. L'extraction étant très-restreinte, le serpentin se réduit à un simple tuyau vertical au centre du réfrigérant, et le débit est réglé à la sortie par le robinet 11. Une éprouvette graduée (13) permet de régler l'extraction au coulage horaire que l'on désire.

Enfin le serpentin intermédiaire (10) sert à l'extraction de l'alcool *pasteurisé*. Nous rappellerons en deux mots ce que c'est que notre *Pasteurisation*, pour les personnes qui ne la connaîtraient pas.

Les vapeurs qui se dégagent du vin et qui arrivent par le réfrigérant R au robinet (8) et à l'éprouvette contiennent à la fois l'alcool et tous les produits plus volatils, appelés produits de tête. Fermons presqu'entièrement le robinet 8, de façon à ne laisser qu'un très-faible coulage, 15 à 20 centim. cubes à l'heure. Tout l'excédant, passant par le tuyau trop-plein N° 9, rentre au haut de l'appareil, et se trouve soumis sur les plateaux à une violente ébullition. Puisque ce liquide contient deux sortes de produits, l'alcool et les aldéhydes, dont le point d'ébullition n'est pas le même, l'ébullition commence par chasser le produit le plus volatil, c'est-à-dire l'aldéhyde. Celle-ci une fois expulsée, le liquide restant est donc de l'alcool purifié de ses impuretés volatiles ; c'est ce que nous avons appelé *l'alcool Pasteurisé*, car il est vieilli artificiellement par notre réchauffage, comme le vin ou les liqueurs sont vieillis par le chauffage dans les appareils dus à Pasteur.

Par le robinet 10 nous extrayons le liquide pasteurisé des plateaux supérieurs ; nous le refroidissons dans le serpentin moyen du réfrigerant H, et le récoltons dans l'éprouvette graduée N° 12, en réglant le débit toujours de la même manière.

L'on remarquera en effet que dans cet appareil minuscule comme dans nos appareils industriels, toutes les extractions diverses se règlent d'une façon invariable comme débit horaire, et cela exactement aux taux que l'on désire sans

troubler l'opération. On peut donc les proportionner aussi bien que possible aux besoins d'après la nature des liquides distillés.

On se souvient que dans nos rectificateurs continus un point capital pour la bonne marche de l'appareil consiste à bien proportionner la quantité d'alcool qui entre par l'alimentation, à celle qui sort des diverses éprouvettes à bon et à mauvais goût. On se base sur le degré alcoolique des huiles amyliques qui doit être maintenu invariable par l'ouvrier distillateur. Si le degré tend à baisser, l'ouvrier doit augmenter légèrement l'alimentation ; il faut au contraire qu'il la diminue si le degré s'élève.

Notre petit appareil présentait ici une difficulté en raison du faible volume de l'extraction. Si l'on soutire 20$^{cc}$ de liquide à l'heure, ce n'est qu'au bout de deux heures environ qu'on a de quoi plonger un alcoomètre ; le renseignement est beaucoup trop tardif. C'est pour parer à cet inconvénient que nous avons mis le thermomètre intermédiaire T', dont les degrés de température correspondent à tout moment à la richesse du liquide extrait par le robinet 11 d'après la loi de Groening.

Grâce à tous ces petits artifices, la conduite de notre appareil de laboratoire est tout à fait calquée sur celles des grands appareils. Il permet par conséquent de faire en petit toutes les études ou recherches que l'on désire, et l'on n'a ensuite qu'à se conformer dans le grand appareil industriel aux indications de meilleure marche que l'on y a observées.

Inutile d'insister sur les autres genres de distillation que l'on peut étudier à fond avec cet appareil ; il nous suffira de les énumérer rapidement :

On peut le faire fonctionner comme épurateur continu des flegmes ; dans ce but on ajoutera un réfrigérant en verre à la sortie des vinasses (Tuyau N° 3) afin de récolter les flegmes épurés refroidis.

On pourra l'employer encore comme Rectificateur continu simplifié, comme ceux que nous montons en Distilleries agricoles, et se rendre compte ainsi des qualités d'alcool que l'on peut attendre d'un flegme donné.

On pourra enfin lui faire faire de la rectification continue complète, puisque, par une opération préalable, on fera d'abord l'Epuration continue du flegme. La rectification continue proprement dite se fera avec le flegme épuré.

L'appareil permettra aussi toutes sortes de recherches intéressantes. On pourra traiter comparativement un même flegme par le charbon de bois à doses variées, ou par les hydrocarbures (procédé Bang et Ruffin), et se rendre compte par la rectification de la finesse comparative des alcools ainsi désodorisés..... etc.

Tous ces essais, impossibles à exécuter en grand, n'ont pu encore être réalisés en petit, parce que l'on n'avait pas l'outil de laboratoire indispensable pour de telles recherches ; car le point indispensable, c'est d'obtenir exactement les mêmes degrés alcooliques que l'on peut atteindre en industrie. Sinon les comparaisons manquent de valeur.

Disons tout de suite que lorsque notre petit appareil universel (nous avons assez justifié ce titre par ses emplois multiples) fonctionne en rectification discontinue, la totalité des 45 plateaux opère comme plateaux rectificateurs.

En rectification continue, partie des plateaux est employée pour l'épuisement ; il reste donc un nombre beaucoup moindre de plateaux rectificateurs proprement dits, de sorte qu'on ne peut prétendre au même degré de force réelle qu'avec la discontinuité. On aurait beau rajouter une quinzaine de plateaux, toujours la discontinuité aurait en supplément les plateaux d'épuisement D. Si l'on voulait faire une comparaison sérieuse, il faudrait donc deux appareils de laboratoire distincts, ayant chacun la même quantité de plateaux affectés à la rectification.

En distillation continue, avec du vin à 11°, nous avons obtenu d'une façon bien régulière un coulage de 355$^{cc}$ à l'heure à 95°,9. L'alcool pasteurisé marquait 95°, 8.

Nous terminerons en disant que notre appareil permettra de produire à l'état de pureté tous les produits chimiques volatils, que nos savants ont tant de peine à fractionner et à purifier avec les anciens appareils. Ces opérations demandaient autrefois des mois entiers, et l'on n'était pas encore certain d'une purification complète. Cette lacune se trouvera comblée désormais.

Enfin nous insisterons sur la caractéristique de cet appareil, qui est une dépense extrêmement réduite en gaz de chauffage. D'après nos essais, un litre d'alcool à 96°,5 ne coûte guère que 800 litres de gaz, soit 24 centimes. Les laboratoires pourront donc revivifier très-économiquement leurs alcools, tout en les remontant au degré maximum. Tandis qu'autrefois l'on dépensait tant de temps et de gaz qu'on ne trouvait aucun bénéfice, même à Paris où les droits sont si élevés, à conserver et revivifier ses résidus alcooliques. Et puis surtout l'alcool régénéré n'était pas assez pur.

Tels sont les points qui nous ont paru constituer pour nos lecteurs une nouveauté instructive à la fois pour les études scientifiques abstraites relatives aux lois de la distillation et de la rectification, et pour les recherches plus spéciales présentant un intérêt direct et journalier pour nos industries.

E. Barbet.
Rédacteur en Chef de la Revue
« L'ALCOOL ET LE SUCRE »
*76, Rue d'Assas, Paris.*

**GEORGES JACQUEMIN**
CHIMISTE
*Place Carrière, 39.*
· NANCY ·

DIRECTION SCIENTIFIQUE
— DE —
**L'INSTITUT LA CLAIRE**
pour la Culture des Levures Pures de Vin.

· LEVURES PURES ·
*Levure pure de raisins*
de grands crus

Procédés Brevetés S.G.D.G

RÉCOMPENSES OBTENUES
depuis la médaille décernée à
L'EXPOSITION UNIVERSELLE 1889.
en 1891:
· EXPOSITION DU TRAVAIL, PARIS ·
Médaille d'or et
trois médailles d'argent.

· AMIENS ·
Médaille d'or.
· ACADÉMIE NATIONALE ·
Médaille d'or.

en 1892:
BLAYE. Médaille d'argent.

· BOURG-SUR-GIRONDE ·
La plus haute récompense
Médaille d'argent.

· CHAMBERY ·
Diplôme d'honneur.

· BARSAC. VERDUN ·
Médaille d'argent.

· LILLE ·
Médaille d'or.

· ACADÉMIE NATIONALE ·
Diplôme d'honneur.

EXPOSITION INTERNATIONALE
DE L'ALCOOL
· PARIS 1892 ·
Médaille d'or.

Nancy, le 25 Janvier 1893

Monsieur Barbet
Paris

Je me sers depuis un mois de votre appareil à rectification continue pour laboratoires. Il fonctionne avec la plus grande régularité et me donne toute satisfaction pour mes expériences relatives à l'influence de la nature de la levure sur la composition du liquide fermenté.

J'ai fait des distillations de bière, de vins, de Kirsch, et j'ai pu obtenir des résultats très intéressants et séparer les divers bouquets de ces liquides. Je m'en suis servi également pour rectifier à nouveau de l'alcool de betteraves, et le produit pasteurisé était d'une neutralité absolue. Enfin cet instrument m'a permis de récupérer l'alcool des résidus de laboratoire, car la dépense en gaz est très minime.

Je compte employer votre appareil pour effectuer un grand nombre d'expériences que je n'aurais jamais pu entreprendre autrefois. Je vous tiendrai au courant des résultats obtenus.

Agréez mes salutations distinguées

G. Jacquemin

Nº 3) afin de récolter

boratoires pourront donc revivifier très-économiquement

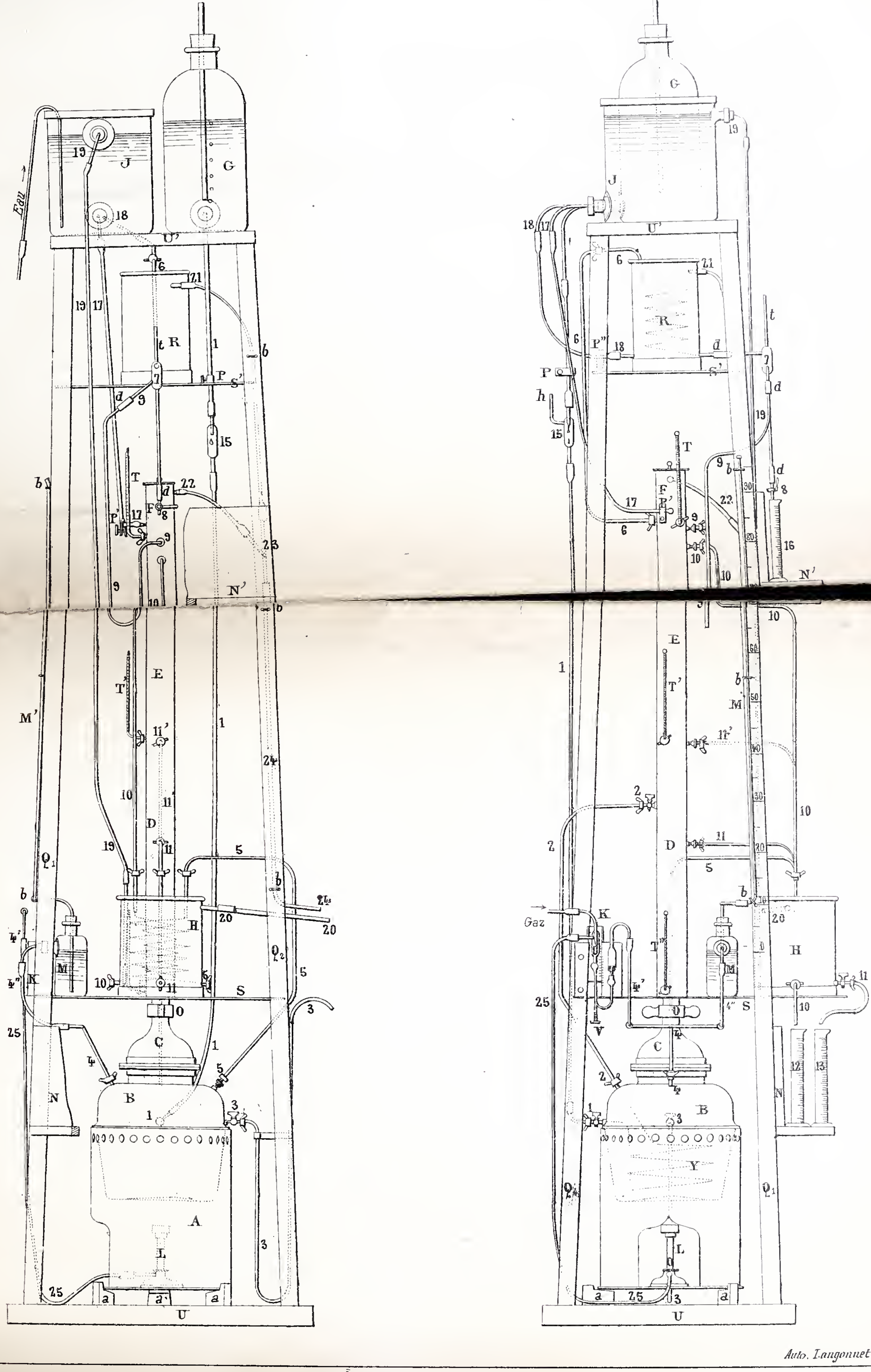
# APPAREIL UNIVERSEL POUR LABORATOIRES

Rectification discontinue et continue,

Distillation continue avec sélection immédiate des divers produits

Vue de face, les planchettes NN' étant ôtées

Vue de côté.




Auto. Laugonnet & Langlet